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I. The Comparative Anatomy and Phylogeny of the Coniferales.

Part 2. — The Abietineae.[1]

By Edward C. Jeffrey.

(Read November 2, 1904.)

Introduction.

In the first number of this series the writer (:03) has called attention to certain features of the anatomy of the genus Sequoia, which seemed to indicate for that genus an Abietineous origin. The results obtained in the case of Sequoia made it desirable that the Abietineae should be somewhat fully examined as a preliminary to the study of the other orders of the Coniferales. This procedure seems further advantageous, because the Abietineae are perhaps the most clearly defined and most accessible of existing Coniferous orders and are at the same time a geologically very ancient group.

The importance attachable to the anatomy of the Gymnosperms has recently been greatly increased by the discovery of the seeds of certain of the Cycadofilices. This alliance established by Potonie ('99, p. 160) on the basis of the morphology and anatomy of the vegetative organs alone, no longer ago than 1899, has recently received the fullest confirmation from the epoch-making discoveries of Oliver and Scott (:03) and Kidston (:03), which, as has been stated by Zeiller (:04), are destined to make a revolution in our conception of the nature of the Palaeozoic flora. By these discoveries, especially when taken together with older, similar ones in the case of the Calamites and Sigillarians, the taxonomic value of the anatomy of plants is placed at once on as secure a footing as that of animals since the time of Cuvier. The study of anatomy, which is so essential and which has recently yielded such important results in the case of fossil plants, has been much neglected in those now living, largely on account of the absence of proper perspective, which can alone be supplied by the knowledge of the older forms. In the case of the Angiosperms this perspective is still unfortunately lacking by reason of our entire ignorance of the nature and structure of their ancestry; but for the Gymnosperms the anatomical researches of the British, French, and German palaeobotanists have now reached a

[1] Harvard Botanical Memoirs. — No. 8.

fullness which makes them of the greatest value in the interpretation of the phylogenetic relationships of the existing Gymnospermous groups. Extremely important results have been obtained in recent years by the anatomical method, in the case of the Ginkgoales and Cycadales; but the Coniferales can scarcely be considered to have been properly investigated in the light of recent additions to our knowledge of the structure of the Cycadofilices, Cordaitales, and other ancient and transitional groups. This statement is made because investigations of recent date on the Coniferales either do not concern themselves with a consideration of the fossils at all, or are devoted to some special theme, such as the structure of the wood, the anatomy of the leaf, etc. Modern work on the anatomy of plant fossils emphasizes the fact that all the organs and tissues should be examined, where successful comparisons are to be made. It will accordingly be the aim of the present investigation to include all the structural features of the Abietineae, so far as they seem to have any bearing on the phylogeny of the order.

Pseudotsuga.

In a transverse section of a vigorous yearling shoot of *Pseudotsuga douglasii* Carr., one sees the comparatively thick fibrovascular ring surrounded by a thick cortex. The wood of this genus is characterized by the presence of resin canals of which there are generally present about three rows. Occasionally one finds shoots in which the resin ducts of the wood are quite absent. The pith is irregular in outline, on account of the occurrence of projections from its periphery corresponding to the outgoing leaf traces. These rays of medullary parenchyma become deeper and deeper as the leaf trace passes outwards from the medullary crown towards the cortex, and where the trace is about to leave the fibrovascular ring there is a radial stripe of parenchyma several cells broad extending entirely through the woody cylinder. This is the foliar gap. Very shortly after leaving the medullary crown, the leaf trace becomes divided into two by a radial row of parenchyma cells, which as the trace begins to approach the outside of the woody cylinder, becomes two and even three layers of cells wide. One or both of the leaf traces at this time may contain a resin canal, which disappears as soon as the trace begins to pass into the phloem. Figure 4, plate 1, shows the topography of the passage of the foliar trace out of the central cylinder and demonstrates that it is distinctly double. It is important to note this point because Bertrand (**74**) states that Pseudotsuga, together with Tsuga and Larix, is characterized by a single undivided leaf trace. In figure 5, plate 1, the leaf trace is seen at some distance out in the cortex, and is obviously

even more strikingly double than when it is leaving the central cylinder. The foliar trace continues as geminate strands for a short distance into the base of the leaf; but soon the two fibrovascular bundles become more or less intimately fused. In a section at some height in the leaf, the trace loses all appearance of being a double strand. This is clearly shown in figure 3, plate 1, which is from a section taken at about the region of the lower third of the leaf of *Pseudotsuga douglasii* Carr. It will thus be seen that the leaf trace of this species becomes double at an early stage in its progress towards the leaf, and that its double nature only becomes obscured after having penetrated some distance into the lamina. The importance of this observation will be apparent at a later stage.

The root of *Pseudotsuga douglasii* is generally diarchous, although examples have been found in which there were as many as three clusters of primary xylem. The primary metaxylem contains no resin canal; but just outside each of the two clusters of protoxylem is a single duct. These features can be seen in figure 2, plate 1. The two first formed resin canals are lined with thin walled, glandular cells, such as occur in the resin ducts of the cortex in the Coniferales in general, and in the ligneous resin ducts of Pinus. The lining of the canals is further particularized by the fact that the cells composing it are quite unlignified and stain a dark blue with haematoxylin. In this respect the tissue in question presents a marked contrast to that lining the later formed ducts of the secondary wood in the root and shoot of the species under discussion, which in most cases is thick walled and distinctly lignified. It not infrequently happens that the primary radical resin canals of Pseudotsuga communicate by radial anastomoses with the resin canals of the cortex. The walls of the radial connecting canals in this case are bounded by the same thin walled, resin secreting cells as are found in the ducts which they unite. These radial anastomoses are most frequent in the neighborhood of an outgoing rootlet, but are by no means confined to this position. In figure 2, plate 1, on the left, may be seen one of the radial canals in question. The plane of section does not include the cortical canal into which it opens. In the cortex of both root and shoot of Pseudotsuga are sclerotic cells; but these do not occur in the phloem as in Tsuga and Abies.

In figure 1, plate 1, is to be seen a section through a wounded portion of the wood in Pseudotsuga. On the left may be seen the margin of the layer of wound tissue, which is closing over the surface of the injured wood. By following this layer towards the right we reach numerous large resin canals along its inner border. These are traumatic resin ducts such as occur almost invariably in the injured wood of the Abietineae. They are characterized by their number, by the fact that they occur in close tangential rows, the ducts of which generally intercommunicate tangentially, and

by the nature of the cells lining their walls. They are apparently for the purpose of sterilizing the wound by pouring large quantities of resin over its surface. Their occurrence in close tangential rows with tangential intercommunication of the ducts is a source of mechanical weakness to the wood, which it is not surprising to find to some extent overcome by the nature of the cells lining the canals. The resiniparous canals in the case of traumatic resin ducts are lined by thick walled, resin secreting cells, which are able to accomplish their function of pouring out a resinous secretion by the presence of numerous simple pits.

In the wood of the cone of *Pseudotsuga douglasii* Carr., there is a single row of resin canals near the medulla. In longitudinal sections the tracheids of the wood in the female reproductive axis are without the spiral bands, which are a well known characteristic of those of the vegetative axis (Penhallow, '96). Although tracheids with tertiary spiral thickenings are absent in both the axis and the scales of the cone in this species, they occur in the leaf traces. This would seem to lead to the inference that their absence in the case of the female reproductive axis is rather due to the thickness of the walls of the tracheids in this organ than that the spiral thickenings in question are not a primitive feature of Pseudotsuga. This inference seems strengthened by the fact that the spiral markings are sometimes absent in the case of the thick walled, aestival tracheids of the vegetative axis. It does not follow, however, that the occurrence of spirally marked tracheids in the wood of Pseudotsuga is any indication of close affinity with the Taxineae, in which they also occur, since the same phenomenon is sometimes found in the hard pines and in Larix (Penhallow, '03).

Larix.

A transverse section of the yearling stem of *Larix americana* Michx. presents very much the same appearance as one of Pseudotsuga. There is in this genus, however, an absence of the sclerenchymatous elements found in the pith and cortex of the last described genus. The leaf bases, too, are more crowded and more prominent and present a rounded contour. There is as a rule but a single layer of ligneous resin canals and this is present in the summer wood. The root of *Larix americana* somewhat resembles that of the genus described above, and has the same commissural radial canals connecting the resin ducts, subtending the two clusters of protoxylem, with those which occur in the so called secondary cortex. This feature is shown in figure 6, plate 1. The lining of the resin canals facing the angles of the primary wood is of the same thin walled, resiniparous cells, which have been described above for Pseudotsuga. The subsequently formed resin ducts of the wood of the root have this thin walled, glandular epithelium

more or less completely replaced by thick walled, resiniparous cells, which are at least partially lignified. There are, however, nearly always some of the more primitive, thin walled cells remaining. The radial canals connecting those opposite the primary wood with similar canals in the secondary cortex have their inner surface also lined with the thin walled type of gland cells. In the stem of Larix, as has been pointed out by Penhallow ('96, '03), the resin ducts of the wood are coated with thick walled, resiniparous cells, presenting in this respect a marked contrast to Pinus.

The leaf trace of Larix is described by Bertrand ('74) as resembling that of Tsuga and Pseudotsuga in remaining a simple undivided fibrovascular strand. An examination of thin sections through the yearling stem of *Larix americana* has shown that the foliar trace here is also double, as in Pseudotsuga described above. The trace sometimes shows indications of duplication even before it leaves the central cylinder of the axis, but generally does not become double until it has advanced some distance into the cortex, in its upward course into the leaf. Figure 7, plate 1, shows the condition of the leaf trace at about the level at which the resin canals of the mesophyll have made their appearance. As is well known (Strasburger, '71), the resin ducts of the fundamental tissues of the leaf in the Abietineae are not generally continuous with the similar canals of the cortex of the axis. At this height the leaf trace as seen in transverse section is obviously double, the tracheary strands being separated from each other by two or three rows of parenchyma cells. These two fibrovascular bundles become intimately fused in the base of the free portion of the leaf, and it is no longer possible to distinguish any signs of duplication.

Picea.

In *Picea nigra* Link, a section of the yearling stem shows the presence of abundant sclerification in the pith. Sclerenchymatous strands are also present in the cortex, subtending the outgoing leaf traces. The woody cylinder normally contains but a single row of resin canals which are nearly midway between the beginning and the end of the annual ring. These canals differ somewhat from those of Larix in their lining, for their parietal glandular tissue is partially thick walled and partially made up of thin walled elements. The latter are always present to some degree and no doubt are responsible for the formation of the tyloses which occur in the canals of Picea, in contrast to those of Larix, where both tyloses and thin walled elements are for the most part absent. The leaf bases of Picea are sharp pointed instead of rounded in transverse section, as is the case in Larix. They are further particularized by the presence of two small resin canals, which in the mature stem end blindly upwardly, although they are intimately in communication with the much larger resin canals of the cortex of the axis. As Mor-

('84) has pointed out, Picea in contrast to the other Abietineous genera, has the resin canals of the leaves at first continuous with those of the stem, but the free communication between the two systems is cut off at an early date by the formation of abscis periderm. This continuity between the foliar and the axial systems of resin canals appears to have been the primitive condition for the Abietineae, but as has been indicated above, has become obsolete in most of the existing species.

Figure 8, plate 1, shows the effect of injury on the structure of the wood in *Picea nigra*. The sparse and small resin canals present in the normal wood are replaced by close tangential rows of resin ducts of much larger lumen, in the folds of traumatic wood, which in the course of time grow over the injured surface of the stem. The reaction which leads to the formation of the tangential rows of canals in the case of injury, is of course much more intense in the immediate vicinity of the wound, and fades away tangentially in the newly formed wood. The traumatic resin canals in question communicate tangentially and have doubtless the function of pouring out resin over the wounded portion of the stem. It is an interesting fact, that the formation of these tangential rows of traumatic resin canals in the Abietineae is most marked in those genera in which the resin canals are normally somewhat sparse or entirely absent. In Pinus, where the resin ducts of the wood are abundant in both the vertical and the horizontal planes, a marked reaction leading to the formation of tangential rows of traumatic resin ducts seldom or never occurs. In Picea, Larix, and Pseudotsuga, on the other hand, their formation is an almost invariable sequel to injury, and this is even more strikingly the case in Abies, Tsuga, Cedrus, and Pseudolarix, which are ordinarily described as entirely lacking ligneous resin ducts. In the genus at present under discussion, I have noticed a strong formation of traumatic resin canals, not only as the result of mechanical injury, but also as a sequel of the attacks of *Chermes abietis*, and of parasitic rust fungi producing witches' brooms.

In Picea the leaf trace is described by Bertrand ('74) as being a double one by the presence of a distinct median medullary ray. In *P. nigra* the foliar trace leaves the central cylinder of the axis as a single strand of very small size. As it reaches proximity to the base of the leaf it becomes distinctly double, as may be seen in figure 9, plate 2. In *P. engelmanni*, which was also examined in this connection, the trace is somewhat larger and the duplication correspondingly more marked. The root in Picea does not differ in any marked features from those of Larix and Pseudotsuga.

Abies.

In *Abies balsamea* Mill., resin canals are normally quite absent in the wood of the shoot. This feature is illustrated by the central portion of figure 10, plate 1. In

the two last annual rings of the figure, dense tangential rows of resin canals can be clearly seen on either side of an injured part of the stem. Figure 11, plate 2, shows a portion of the traumatic wood on the left of figure 10 more highly magnified. In this case it is easy to make out that the resin canals are more or less strikingly in tangential communication with each other, and that they occur in the spring wood of each of the annual rings formed subsequently to the injury of the stem. The canals in question pour out a large amount of resinous secretion over the surface of the injured wood, and by their presence as a reaction to injury only afford a much more economical provision for antisepsis than the numerous resin canals which occur throughout the wood of Pinus. In the annual rings of the stem shown in figure 11, both in those containing resin canals and in those without resin canals, may be seen certain minute dark dots. These are especially noticeable, in spite of the low magnification, in the annual ring immediately preceding those which contain resin canals. These dots are the so called resin cells, which are frequently characteristic of those Coniferous woods which do not contain resin canals under normal conditions. The dark color which is a feature of the cells in question is due to the presence of a tanniniferous substance. In figure 12, plate 2, is seen a part of the woody tissue from the axis of a witches' broom of *Abies balsamea*. It is clear from this figure that resin canals of the tangentially crowded traumatic type are also present as the result of the attack of the fungus producing the witches' broom. This feature has been described by Anderson ('97) and other pathologists. It is to be further noted that the place of occurrence of the rows of traumatic resin ducts is in general the same in the species under consideration, *viz.*, in the spring wood.

In figure 13, plate 2, is seen part of a section of an injured stem of *Abies magnifica* Murr. The area of the figure is all contained within the breadth of a single annual ring, yet there are four rows of traumatic resin canals. This is the largest number occurring within a single annual ring of wood which has come under my notice. Generally in the various species of Abies there is but a single row of such ducts in a year's growth. The position of the row of traumatic resin canals is usually constant in the same species, and they may lie either in the spring or summer wood or in an intermediate position.

Figure 14, plate 2, brings out an interesting peculiarity in the structure of the wood of *Abies magnifica*. In this species the resin canals which are normally absent in the wood of the vegetative axis are found to occur with great constancy in the woody axis of the cone. I have already referred to a similar phenomenon in the first memoir of this series devoted to the anatomy of Sequoia. In *S. gigantea* in all the numerous cones which have come under my notice from various sources, resin canals have always appeared in the axis of the female cone, although they are normally quite absent from the annual rings of the older parts of the stem and branches. I have had access to four

different examples of the large cones of *A. magnifica*, three of which were from entirely different sources. Rows of resin canals such as appear in figure 14, occurred in all of them. Special care was taken to observe whether the cone or its peduncle had suffered injury in any of these examples; but in all the cases examined both organs were quite normal in every way. Figure 15, plate 2, shows a part of another section of the same cone as that shown in figure 14, more highly magnified. The plane of section in this case is lower down in the cone, and the figure as a consequence, although under a greater magnification than the preceding one, shows the resin ducts of smaller size. The resin ducts become fewer and of less caliber as the base of the cone is reached, until finally in the peduncle, or even above the actual peduncle, they disappear altogether. If instead of progressing towards the base of the cone, one moves in the opposite direction, the resin ducts instead of becoming fewer and of smaller size, are found to have larger lumina and to become more numerous. The larger ducts of the upper part of the cone by reason of their greater size and close proximity tend to become fused with one another, as is clearly shown in figure 16, plate 2. The resin secreting cells which surround the resin ducts of the woody axis of the cone in the species under discussion are thick walled and are quite similar to those surrounding the resin passages in the wood of Larix. Thin walled, resiniparous cells are, however, occasionally found where a resin canal abuts directly on a medullary ray. Although a good deal of brown tanniniferous secretion is found in the medullary rays of the cone, little or none appears in the parenchymatous cells surrounding the resin ducts.

In the memoir on Sequoia reference is made to the fact that resin canals occur in the *first* annual ring only of vigorous shoots, in the case of trees which have already produced female cones. Interestingly enough, the same state of affairs has been found by the writer in the case of the present species. Figure 17, plate 3, reproduces the two first annual rings and part of the third in a cone-bearing branch of *A. magnifica* from the collection at the Arnold arboretum of Harvard university. I am indebted to Mr. George S. Shaw and Prof. Charles S. Sargent for the opportunity of examining authentic material of the present and other species studied in connection with the present work. The magnification is just sufficient to show the presence of resin ducts which are entirely confined to the first annual ring of the four year old shoot in question. There was no evidence of any injury to the branch, so the presence of the ducts must be regarded as a perfectly normal feature, especially in view of other similar observations shortly to be recorded. In the stouter lateral branches of the shoot in question there was in some instances a similar occurrence of ducts in the first annual ring; but in the more delicate twigs these were entirely absent, thus duplicating the similar phenomenon found in *S. gigantea*. Figure 18, plate 3, shows the structure of the first and second annual rings

in a two year old branchlet from a cone-bearing branch of a different specimen of *A. magnifica*. Resin canals are clearly present in the first annual ring and absent in the second. No injury to the tissues could be made out in the case of this branch any more than in the case shown in figure 17 of plate 3. In figure 19, plate 3, is shown a cross section of the internal region of the woody ring of a vigorous branch from a flourishing specimen of *A. magnifica*, between 8 and 10 meters high, growing in the Hunnewell pinetum at Wellesley, Mass. Resin ducts are present here as well as in the other cases. In less vigorous branches from the lower part of the tree the resin ducts do not appear. In figure 20, plate 3, a portion of a section from the same branch as that appearing in figure 19 is represented more highly magnified to show the nature of the resin ducts and of the cells forming their walls. It will be seen that the ducts under consideration are quite close to the primary wood. They are obviously surrounded by the same thick walled, resiniparous cells as occur normally in all the annual rings of Larix. The magnification is sufficient to show the presence of nuclei in four or five of the parietal cells of the ducts. The nuclei present in the remaining cells have been missed by the plane of section. To summarize, resin canals surrounded by thick walled, epithelial cells, such as are found about the ducts in the annual rings of Larix, occur in the first annual ring only of vigorous branches from vigorous trees of *Abies magnifica*.

In longitudinal section the pith of branches of *A. magnifica* presents a curious appearance, which is shown in figure 21, plate 3. The medulla is crossed by diaphragms consisting of sclerotic tissue, and alternating with these are segments of soft parenchyma, which tend to break down, thus producing a fistular medulla, such as occurred in many of the Cordaites. Sir J. William Dawson ('88) was the first one, so far as I am aware, to call attention to this feature in the genus Abies. It is referred to here because it appears to have a certain significance in connection with other facts to be described and discussed at a later stage. Noticed by Dawson first in the case of *A. balsamea*, it seems to be thoroughly characteristic of the genus, but occurs also in the curious Cedrus-like species, sometimes united under the subgeneric name Keteleeria.

In figure 22, plate 3, is seen a transverse section of a root of *Abies nobilis*, a species somewhat closely allied to *A. magnifica*. The root of the latter species differs from it only in unimportant details. The most striking feature of this root is the presence of a resin canal in the center of the primary wood. This peculiarity has been noted by De Bary ('84) as being common to the genera Cedrus and Abies. To these Strasburger ('91) adds the so called Chinese larch, Pseudolarix. The central resin canal in the case under discussion is surrounded by several layers of delicate parenchyma cells, the innermost of which functions as the resiniferous epithelium. There are normally no resin canals present in the secondary wood of the root of Abies, and the examination of a consider-

able number of roots of different species of the genus from the Arnold arboretum of Harvard university and from the Hunnewell pinetum at Wellesley, Mass., has revealed no exceptions to this rule. The cells of the phloem in the root of Abies are sometimes very small. As an example of this feature *A. magnifica* may be cited. Sclerotic nests of cells are somewhat constantly present in the so called secondary cortex of the root in Abies, and may clearly be seen in figure 22. Resin ducts occur occasionally in the same situation, but there is never any communication between these and that which is present in the first annual ring of the wood.

In figure 24, plate 3, is shown a transverse section through the woody axis of the cone of *Abies appolinis*. This is the only species of the Old World in which resin canals have been found in the wood of the reproductive axis. Two cones, which as far as could be learned were from different sources, showed this peculiarity. In the one figured there are two rows of resin ducts present extending completely round the cone, although somewhat better developed on one side than on the other. Figure 25, plate 4, shows a portion of a similar section more highly magnified. The resin canals in this case do not become very large towards the top of the cone, as in *A. magnifica*, but resemble those of the former species in disappearing entirely at its base. The cells which surround the resin canals are characterized by the presence of a small amount of tanniniferous material in the form of minute granules, but they contain much less of it than do the cells of the medullary rays. *A. apollinis* differs from *A. magnifica* in that the resin ducts of the wood of the stem are confined to the axis of the cone, and do not appear in the first annual ring even of vigorous vegetative branches. The only other species of Abies in which resin canals have been found in the cone is *A. grandis*, as has been described in the first memoir. Here, however, the occurrence of the resin passages appears to be sporadic, for they have only been observed in a single specimen and are absent in four others. In *A. balsamea*, *A. fraseri*, *A. concolor*, *A. amabilis*, *A. nobilis*, *A. bracteata*, *A. veitchii*, and *A. cephalonica* no resin canals were found in the woody axis of the female cone. *A. nobilis* was erroneously described in the first memoir as possessing resin ducts in the wood of the female cone. The cone in which these structures were found turned out to be incorrectly diagnosed, and was really *A. magnifica*. Keteleeria in its anatomy obviously belongs with Abies although it has the habit of Cedrus; the wood of both vegetative and reproductive axes is entirely without resin canals.

The leaf trace of Abies is often double, even in the lamina, and where a geminate fibrovascular strand cannot be distinguished in the blade of the leaf, it can usually be made out in the part of the trace which runs in the cortex. This, for example, is the case in *Abies magnifica*, where the foliar trace does not give clear evidence of being a double strand in the free flattened portion of the leaf. By following the trace down into

the cortex of the axis its double character can generally be clearly distinguished. Bertrand ('**74**) describes a double trace as characteristic of the genus Abies in general, and to this statement I can subscribe. In figure 23, plate 3, is represented a foliar trace of *A. magnifica* in transverse section at a height of two millimeters in the free part of the leaf. The striking feature of this figure is the fact that the transfusion tissue, connected with the bundle of the leaf in this as in most other Conifers, is unusually abundant, and instead of forming a scattered reticulum about the fibrovascular strand, interspersed with living parenchyma cells as is the rule, constitutes a dense and continuous ring of tracheidal tissue, completely surrounding the phloem. There is a tendency for it to become interrupted opposite the cambium on either side of the bundle by parenchyma cells. The condition of the transfusion tissue found in this case is to be compared with that recently described by Miss Stopes (:**03**) in the leaf of a Cordaite, probably the *Cordaites principalis* of Renault. In his description of the bundles of this leaf, Renault interprets a layer of tracheary tissue outside the characteristic centripetal wood, found so commonly in the leaves of the more ancient Gymnosperms, as centrifugal so called phanerogamous wood, similar to that occurring, for example, in the bundles of the petiole of the Cycads. Miss Stopes has pointed out that this so called centrifugal wood is separated from the centripetal xylem by a layer of irregularly disposed, thin walled tissue comparable in every way to primary phloem. Moreover the tracheary tissue in question is attached to the flanks of the centripetal wood, and its elements, arranged in the form of a double sheath, correspond to the transfusion tissue of the Conifers and other Gymnosperms.

In this connection Miss Stopes calls attention to the researches of Worsdell on transfusion tissue in the Gymnosperms. Worsdell ('**97**) reaches the conclusion that the transfusion tissue, "which occurs almost universally in the leaves of Gymnospermous plants as an auxiliary conducting system, has been phylogenetically derived from the centripetally formed xylem of the vascular bundle." In the example in figure 23, plate 3, the transfusion tissue extends well round towards the back of the flanks of the bundle, and there are even some elements formed in a centripetal direction. Miss Stopes draws the conclusion that the sheath described by her in *Cordaites principalis* is not centrifugal wood, but "a primitive stage in the development of transfusion tissue from centripetal xylem." The condition of affairs shown in our figure 23 seems to be strong evidence for the truth of this hypothesis, and it supplies a transition from the condition ordinarily found in the Conifers to that sometimes found in Cordaites as described by Miss Stopes. At a higher level in the leaf the continuity of the transfusion tissue on the outside of the phloem is generally lost, and we have resulting a condition in which there are merely massive wings of transfusion tissue on the flanks of the bundle, a state of affairs which is permanently present in Sequoia, Cunninghamia, etc. A good figure of this arrangement of the

transfusion tissue in Cunninghamia appears in De Bary's textbook ('84). There is another possible fate for the transfusional sheath, however. Instead of becoming interrupted opposite the phloem, it may only suffer a sort of general disintegration by the intrusion of parenchyma cells into its mass. This condition is exemplified by Pinus as described by Strasburger ('91, p. 133). The interesting arrangement of the transfusion tissue represented in figure 23, plate 3, is not confined to *A. magnifica*, but also occurs in a less marked degree in the allied species, *A. nobilis* and *A. bracteata*. In these species, too, the sheath tends to become discontinuous in the upper part of the lamina of the leaf. This is especially true of *A. bracteata*.

Pseudolarix.

Although this genus, in spite of its deciduous cone scales, is generally put in proximity with Larix on account of its deciduous foliage, its anatomy as will be shown in the sequel makes it desirable to place it with Abies.[1] Figure 26, plate 4, is of a nine year old branch of *Pseudolarix kaempferi*. In the first six annual rings the wood closely resembles that of Abies, as shown in our figure 10, plate 2. In the seventh year of growth the stem suffered injury and as a result there is a great hypertrophy of the wood in the region of the wound, accompanied by a corresponding reduction in the thickness in the region of the annual rings, which is on the opposite side of the stem. In the first annual ring formed after injury there are tangential rows of resin canals running backward from the wound on either side. In figure 27, plate 4, some of these canals from the right hand side of the foregoing figure are represented under a higher magnification. The canals in this case are surrounded by cells containing more or less starch. Similar starch-bearing cells occur normally as a single row on the face of the aestival wood of each annual ring. The cortex and phloem of Pseudolarix are characterized by the presence of numerous mucilage cells, which become very large externally. In figures 26 and 27 they are emptied of their mucilaginous contents, which are very soluble in the aqueous stains most suitable for differentiating sections for photomicrography, the method of illustration used throughout this article. There are no resin canals present in the cortex of the vegetative axes of Pseudolarix. They do not appear even in the cortical tissues of the seedling. As has been shown above, they are equally absent in the ligneous tissues. There is this difference between the wood and the cortex in regard to the absence of resin ducts, *viz.*, that they may be produced in the wood as the result of injury, whereas they never occur in the tissues of the cortex under this condition. Not even in the most vigorous vege-

[1] Since the above was written I have had the opportunity of examining male cones of Pseudolarix. The pollen has air sacs like that of Abies and Cedrus, and in this feature presents a marked contrast to Larix.

tative shoots of the genus under consideration have I ever found resin ducts in the first annual woody ring, such as occur in *Abies magnifica* as described above, and in *Sequoia gigantea* described in the former memoir.

The root of Pseudolarix closely resembles that of Abies, for it has the same central resin canal in the primary wood and numerous mucilage cells in the cortex as well. The sclerotic nests which are characteristic of the cortical tissues of Abies are absent in the present genus. Figure 28, plate 4, sufficiently illustrates the truth of the statements made above. The dark cells appearing in the cortex contain tannin, while the large empty ones are those which in life contain mucilage. In figure 29, plate 4, a part of another root is represented. In this instance the section was treated with chrome alum, in order to render the mucilage insoluble in the aqueous dyes employed in staining. In one of the mucilage cells on the extreme right of the figure the contents, although rendered insoluble by the use of chrome alum, have come out bodily, and are lying over some of the other cells. The central resin canal, which is always present in the root of Pseudolarix, is surrounded by parenchymatous cells with thin walls of unmodified cellulose, and thus closely resembles that of Abies.

In figure 30, plate 4, appears a transverse section of the ligneous portion of an injured root from a seedling from Pseudolarix. The magnification is sufficient to show a semicircle of resin ducts running off from the margins of the wound. There is no corresponding formation of traumatic resin canals in the cortical tissues, which, like those of the stem are normally entirely without resin ducts. I have had no opportunity of examining the reaction of the root in the mature plant of Pseudolarix when injured, but there seems no reasonable doubt that the result would be the same as in the stem of the seedling described above.

Figure 31, plate 4, shows the structure of a three year old branch of Pseudolarix as seen in transverse section. The material in this case came from a large tree growing in the Hunnewell pinetum at Wellesley, Mass., which has produced cones abundantly for a number of years. From the seed of this tree a number of seedlings have been grown by Mr. Jackson Dawson at the Arnold arboretum of Harvard university, so that there can be no doubt as to its vigor. There are no resin canals present, either in the cortex or in the wood. The empty spaces seen in the fundamental tissue are the mucilage cells referred to above. In figure 32, plate 4, is a transverse section through the bracteolate portion of the peduncle of a female cone of the species under consideration. Resin canals are equally absent in both wood and cortex. The mucilage cells of the cortex in this case are much fewer in number than they are in the vegetative axis, and in the higher portion of the peduncle they disappear entirely.

In figure 33, plate 5, is shown part of a transverse section of the axis of the female cone in Pseudolarix. On the lower side of the figure may be seen a few small bundles belonging to the fibrovascular ring of the cone axis. On the inner side of these is a dense mass of sclerenchymatous tissue, which is the only part of the cone left hanging to the tree after the very deciduous ovuliferous scales have fallen away, carrying with them piecemeal the bundles of the axis to which their own fibrovascular supply is attached. Outside the ring of fibrovascular bundles, the cortical tissues of the reproductive axis are for the most part made up of delicate parenchyma cells; but these are interspersed with a considerable number of short stone cells, which make the cutting of suitable sections of the axis a rather difficult matter. The most interesting features of the cortex of the cone, however, are the presence of resin canals similar to those occurring in the cortical tissues of all the organs of most of the Abietineae, and the absence of the mucilage cells, such as are found in the vegetative cortex of Pseudolarix. The resin canals in the present instance are quite large in size, and do not appear at once in the base of the cone proper. Further, they are of short length and do not intercommunicate with each other, a fact which makes the proper infiltrating of the axis with celloidin somewhat difficult. In figure 34, plate 5, is seen a section through the base of one of the ovuliferous scales and its subtending bract. The ovuliferous scale is very large and only a small part of it is shown on the upper side of the figure, while the bract is so small as to be entirely included. The sterile bract has not yet become free from the lower surface of its ovuliferous scale and does not show the presence of any resin canals. The magnification is not sufficient to show that the fibrovascular strand of the bract is double. In the tissues of the ovuliferous scale proper there are numerous quite typical resin canals, such as are characteristic of the cortical tissues of the other Abietineae. These canals are continuous with the similar canals already described in the case of the axis of the cone.

In figure 35, plate 5, is a section of the sterile bract at a point some distance above its separation from the face of the ovuliferous scale. The fibrovascular bundle has shrunken badly as the result of imperfect preservation in an insufficient amount of alcohol. The important point to note in the present figure is the presence of a pair of resin canals, one on each side of the gap in the tissues corresponding to the position of the fibrovascular bundle.

Figure 36, plate 5, represents a cross section of one of the rather slender leaves of Pseudolarix under a considerable degree of magnification. The histological elements present are very small so it is not easy to make out that there are present five resin canals on the margin of the mesophyll and over against the hypoderma, which surrounds the leaf underneath the epidermis. Of these canals three are on the upper surface, one of which is median and two lateral; the remaining two canals are placed laterally on the

lower border of the leaf. It will thus be seen that resin ducts are present in the cortical tissues of the leaf in Pseudolarix, as well as in the female reproductive axis, although they are quite absent from the cortex of the stem. From the fact that there are two resin canals only present in the leaves (*i. e.*, sterile bracts) of the female reproductive axis, it may perhaps be inferred that two is the primitive number for Pseudolarix. It should be stated at this point that the two resin canals of the sterile bracts end blindly below, just as do those of the ordinary vegetative leaves, in spite of the fact that the axis to which they are conjoined, unlike the vegetative, possesses cortical resin ducts.

It will be seen from the foregoing paragraphs that resin ducts are present in the wood of Pseudolarix under two conditions, *viz.*, normally in the primary wood of the root and as the result of injury in the secondary wood of both root and shoot. In the cortical tissues they are normally present in the reproductive axis, the ovuliferous scales, the sterile bracts, and the ordinary vegetative leaves. They do not occur in the vegetative branches nor the root even in response to injury.

It may be noted by looking a little closely at the fibrovascular bundle of the leaf of Pseudolarix, reproduced in our figure 36, plate 5, that the leaf trace is double, being divided into two by a parenchymatous strand passing through the xylem. As in the genera already described, the leaf trace in the genus under consideration is very distinctly double in the outer cortex of the axis, although it departs from the central cylinder as a single strand as in Picea.

Cedrus.

In the case of this genus we shall first examine *Cedrus atlantica*. The material studied came from a small tree of the variety *glauca* growing in the Hunnewell pinetum at Wellesley. As is well known, those fossil woods which are without resin cells or resin ducts, which do not possess spirally marked tracheids, and have their bordered pits opposite and not alternating in the same tracheid, are united in the structural genus Cedroxylon. The characters just enumerated are found in the wood of *Cedrus atlantica*. Although resin canals are normally absent in the wood of this species, they occur frequently as a result of injury under the same conditions as in the genera previously described. Figure 37, plate 5, shows the structure of the wood on the margin of a wound in the species being considered. Resin ducts of the usual type form a continuous row to the right of the area of injury. The cells surrounding the canals in this case are thick walled and partially lignified as in the traumatic resin canals of some of the other genera described above. They are enabled to pour out their secretion by the presence of numerous pits. In figure 38, plate 5, is seen a transverse section of a wounded root of Cedrus

atlantica. Running in a circular fashion through the wood is a tangential row of traumatic resin canals. It is an interesting fact that in Cedrus the lining of the traumatic resin canals of the injured root is different from that found in the stem under the same conditions. Instead of the glandular cells in this case being thick walled and lignified as they are in the stem, they are thin walled and of pure cellulose, and in fact strongly resemble in their characteristics the resiniparous lining of the normal resin canals of the wood in Pinus. Figure 39, plate 5, sufficiently illustrates the structure of the traumatic resin ducts of the wood of the root in *Cedrus atlantica*. It will be seen in this highly magnified representation of the canals, that they are lined with thin walled cells, containing protoplasm and a nucleus. No resin canals are formed as a result of injury to the cortical tissues of either the stem or the root in *C. atlantica*. Before leaving the discussion of this species, reference must be made to an interesting phenomenon, which occasionally is present in wounded roots. Ordinarily only vertical resin canals are produced as the result of injury to the tissues of the wood in *Cedrus atlantica*; but in one case which has come under my notice horizontal canals were present as well. These started from the vertical canals and ran for a short distance radially outward, and then ended blindly. Like the vertical resin ducts of the root they were lined with thin walled, glandular epithelium and not with thick, lignified, resiniparous cells such as are found in the stem. I have not found horizontal resin canals in the stem of *C. atlantica*; but this is probably to be explained by the fact that my material was limited rather than to their being non-existent, for I have observed such horizontal canals frequently in material of *Cedrus deodara*, to be described below.

In figure 40, plate 5, is seen a part of a transverse section of the wood of *Cedrus deodara*. Crossing the lowest annual ring in the figure and in the summer wood is to be seen a row of resin ducts, which we may compare with those occurring as the result of injury in *C. atlantica*. Although the piece of wood did not actually show the presence of an injury in this case, there appears to be little doubt that the tangential row of resin canals occurring here is due to a wound either above or below the region from which the block of wood was cut. This appears extremely probable, since traumatic resin canals occur far above and below the actual spot of injury, as has come under my observation many times in American genera of the Abietineae, and in Sequoia, in which, as has been shown in the first memoir, similar conditions occur. It is further to be noted that the resin ducts in *C. deodara* occur in the summer wood, in contrast to *C. atlantica*, where they are found in the spring wood. The two species differ from each other in this respect in the same way as do *Sequoia sempervirens* and *S. gigantea*. It is worth while to call attention to the different position of the traumatic resin ducts of the two species of Cedrus under discussion as it furnishes a means of distinguishing their woods. Similar differ-

ences in the place of formation of the traumatic resin canals occur, as has been pointed out above in the case of different species of Abies. Unfortunately I have not had access to material of the wood of *C. libani*. The only specimens available were seedlings of the species growing in the nursery of the Arnold arboretum, of Harvard university. None of these showed injury, as they had been grown with great care. As a consequence they were useless for my purpose.

Another striking feature of figure 40 is the presence of a single horizontal resin duct passing radially outward from the row of tangential ducts. In figure 41, plate 6, is seen another example of a horizontal resin canal from the same material. The horizontal ducts in the two figures just described ended blindly and did not communicate externally with other similar ducts running in the vertical plane. Often, however, when two rows of traumatic vertical canals occur near each other in the wood, horizontal ducts extend from the one series to the other. Such an instance is clearly shown in radial section in our figure 42. Very often these radial ducts conjoining different tangential rows of vertical ducts, are very much larger in caliber than are the vertical ducts. This feature appears clearly in figures 42 and 43, plate 6. In figure 43, the horizontal canal extends beyond the second series of vertical ducts only to end at a short distance to the outside of it. It should here be stated that the horizontal ducts, so far as my observations go, always start with a series of vertical ducts and run radially outwards, ending blindly or joining with a more exterior series of vertical canals. They never pass inward from a vertical series of resin ducts, which is another argument for their being entirely a traumatic phenomenon. Figure 44, plate 6, is a tangential section of the wood of *Cedrus deodara* in a plane outside the vertical row of resin canals shown on the left of figure 43. It will be observed that in addition to the small linear rays, which are normally present in the genus Cedrus, there is a number of large, so called fusiform rays. Some of these enclose a resin canal, while others do not. The smaller fusiform rays are cross sections of resin canals which have ended blindly, while those which are of larger size contain obvious resin ducts, which are becoming narrower of lumen, but which have not yet been occluded.

Figure 45, plate 6, shows part of the transverse section of the axis of a cone of *Cedrus atlantica*. In the row of bundles which occurs on the upper side of the figure there are no resin canals in the woody tissues. The cavities, appearing on the outer sides of the wood bundles, indicate the position of the collapsed phloem, the section being made in this instance from dry material. Resin canals occur in the cortex only of the female cone of *C. atlantica*. Cones of *C. libani* and *C. deodara* were examined with similar results. In no case have I found resin ducts in the woody tissues of the cone in the genus Cedrus.[1]

[1] Radais ('94) has, however, described resin canals in the first year's growth of [illegible]

In figure 46, plate 6, is a cross section of the root of *Cedrus atlantica*. The center of the primary wood is occupied by a resin canal of considerable size, which is surrounded, as in Pseudolarix and Abies, by thin walled cells of the secretory parenchyma. The walls of the gland cells in Cedrus are of pure cellulose. The presence of a median resin canal in the root of this genus has already been described by De Bary (**'84**). The secondary wood of the root in the various species of Cedrus contains no resin ducts except in the case of injury. There are no sclerifications either in the bast or in the cortex, and mucilage cells are absent as well. In the smaller roots which have been mainly examined there were no cortical resin canals, although these are abundant in the stem.

The leaf trace of Cedrus is described by Bertrand (**'74**) as showing some evidence of duplication by the presence of a very distinct median medullary ray. In the cortical course of the leaf trace it is obviously double, as in the case of the other Abietineous genera described above.

This condition is shown in figure 47, plate 6, which represents the foliar trace of *Cedrus atlantica* as it is passing through the cortical tissues on its way to the leaf. A similar state of affairs has been made out in the leaves of seedlings of *Cedrus libani*. It will thus be seen that in its outgoing leaf trace Cedrus is no exception to the condition of affairs described above for the other Abietineae. Although the foliar trace in this genus is geminate in the middle and outer cortex, it nevertheless leaves the central cylinder of the axis as a single strand.

Tsuga.

In figure 48, plate 6, is shown a transverse section of an injured stem of *Tsuga canadensis*. There are four normal rings of wood present and part of another. The injury took place obviously in the early summer of the fifth year of growth of the branch represented in our figure. From the mode of formation of the traumatic wood it is clear that the injury must have been very severe, for the first ring of woody tissue formed subsequently to this event extends only half way around the stem. Although the magnification is not great, it is obvious that resin canals are present in the usual tangential row, which is characteristic of the traumatic canals in the Abietineae in general. The resin ducts are situated in the early formed part of the traumatic wood. The usual position of the resin ducts in the injured wood of *T. canadensis* is in the later formed portion of the spring wood. This is clearly seen in the case of large wounds in thick stems, where a number of years is necessary for the closing over of the exposed surface by

traumatic wood. Under these circumstances tangential rows of resin canals are formed in the spring wood of successive but generally not consecutive annual rings. Although a good deal of material has been examined from various sources and of wide geographical distribution, no examples of horizontal resin canals have been found such as are present in Cedrus, described above. The resiniparous cells lining the interior of the traumatic resin ducts in Tsuga are thick walled and much pitted. They frequently contain dark brown tanniniferous globules or masses, similar to those found in the resin cells of the normal wood of Tsuga. Traumatic resin canals of a similar nature have also been found in *Tsuga mertensiana*. In this species they are entirely confined to the aestival wood. It is thus possible to distinguish the two species by the reaction of their wood to injury.

In figure 49, plate 7, appears a transverse section of a yearling stem of *Tsuga canadensis*. Although the branch is a vigorous one there is no evidence of the presence of resin ducts. Even in the most flourishing branches of *T. canadensis*, bearing female cones, there are no resin canals present in the first year's growth, such as are found in similar shoots of *Abies magnifica*. Another feature of Tsuga shown in the figure is the entire absence of cortical resin canals. This condition is likewise present in *T. mertensiana*, which resembles *T. canadensis* in the structure of its woody tissues. The cortex of the two species mentioned is also free from the mucilage cells which are such a striking feature of this tissue in Abies and Pseudolarix.

In figure 50, plate 7, is shown part of a transverse section of the cone of *Tsuga mertensiana*. Although there are still no resin ducts in the wood of the large cone of this species, they are obviously present in the cortex. On the right of the figure two very large ducts are about to pass off into the fructiferous scale. Figure 51, plate 7, shows a similar view of a transverse section of the cone axis of *T. canadensis*. In this case, too, cortical resin canals are present although there are no ligneous ones. On the right and left of the figure, ducts are to be seen passing out into the two fructiferous scales which are included in the plane of section. It will be seen that Tsuga resembles Pseudolarix in the distribution of cortical resin canals in the vegetative and female reproductive axis, for as in the latter genus, they are present in the reproductive axis and in the fructiferous scales, but are entirely absent from the cortex of the vegetative stem. As is well known, there is a single median resin canal present in the mesophyll of the vegetative leaf of Tsuga.

In figure 52, plate 7, is represented a transverse section of the root of *Tsuga mertensiana*. The magnification is just sufficient to show the presence of a median resin duct in the primary wood. There are no resin canals present either in the

secondary wood or in the secondary cortex which appear in the figure. Figure 52 shows the structure of a three year old root of *Tsuga canadensis*. There is the same median resin duct as in the preceding figure, but no resin canals appear in the secondary wood, the phloem, or the cortex. In figure 54, plate 7, is shown a section of a wounded root of *T. canadensis*. There is a row of resin canals present in the traumatic wood formed subsequently to the receiving of the injury. The cells surrounding these canals are of the thick walled type, and they often contain considerable tanniniferous substance. Figure 55, plate 7, reproduces the structure of the central portion of the primary wood and part of the secondary wood which lies about it. The parenchyma separating the primary from the secondary wood contains a large amount of tannin, but the cells surrounding the resin canal in the center of the primary wood are obviously free from this substance. The resiniparous lining of the median resin canal of Tsuga is thicker walled than in Pseudolarix, Abies, and Cedrus, but its cells are nevertheless quite typical resin-secreting elements. In figure 56, plate 7, is shown the passage of a leaf trace into the leaf in *Tsuga mertensiana*. The trace is plainly double in this instance, as in the other Abietineae described in this investigation. Bertrand (**74**) cites Tsuga as a genus possessing a single leaf trace. If the exit of the trace from the central cylinder be studied in this genus, it becomes evident that the fibrovascular strand is clearly duplicate even before it leaves the wood of the axis, and persists as an obviously geminate strand up into the base of the leaf proper. *Tsuga canadensis* was examined with the same result, although here the size of the strands of the double trace is somewhat smaller. With the description of the leaf trace in Tsuga, the consideration of the recognized genera of the Abietineae, with the exception of Pinus, is completed. In the following paragraphs the bearing of the observed facts on the phylogeny of the order will be discussed.

Conclusions.

Having examined from a comparative standpoint the general features of the anatomy of the Abietineae, we are now in a position to discuss the significance of the facts described, in connection with the affinities and phylogeny of the order. The discussion may conveniently be divided under three heads: (1) The bearing of anatomy in the broadest sense on the interrelationships of the various genera of the Abietineae; (2) The relationship of the Abietineae to the other groups of the Coniferales; (3) The affinity of the Abietineae with other groups of Gymnosperms, living and extinct. These will be considered in the order in which they have been mentioned.

The interrelationships of the Abietineae.—In the foregoing paragraphs it has been

noted that certain genera of the Abietineae were characterized by the abundant occurrence of resin canals in the secondary wood of their vegetative and reproductive axes and in the secondary wood of the root as well. In these genera resin canals are also abundant in the cortical tissues of all the organs. They are further characterized by their persistent cone scales.

In contrast to these are a number of genera in which the resin canals, so abundant in the forms just described, are almost entirely absent in the secondary woody tissues of the vegetative and reproductive axes. Where they do occur in the secondary wood of the stem organs, they are confined to the female reproductive axis, and to the *first* annual ring of vigorous branches of sexually mature trees. These genera are further particularized by the fact that in the woody tissues of the root, resin canals are confined to the primary wood, but are never absent from this position. In the cortical tissues of some of the genera included in this group, resin canals are abundantly present, but in others they occur only in the female reproductive axis and its appendages, and in the mesophyll of the leaves. Although resin ducts are normally absent in the secondary wood of the vegetative axial organs of the genera under discussion, their formation may be brought about in dense tangential rows by the attacks of fungi, or by mechanical injury. Finally the genera included here are with one exception characterized by deciduous cone scales.

The genera to be included in the first group are Pinus, Pseudotsuga, Larix, and Picea. The second group contains the genera Abies, Pseudolarix, Cedrus, and Tsuga. It seems advisable to include the first four genera in a special subfamily, the Pineae, and the last four in another special subfamily, the Abieteae. These two series are so distinct in both their reproductive and anatomical characters, that it will conduce to a clear understanding of their phylogenetic relationships to keep them separate under the designations which have been suggested above.

Having separated the genera of the Abietineae into two distinct groups we may now go on to inquire how these two groups are related to each other and which of them is the more primitive. Further, after having as far as possible from the data here made available, settled their general relationship, we may advantageously pass on to the consideration of the affinities of the several genera which they include.

As a preliminary to the discussion of the relative antiquity of the Pineae and Abieteae as here defined, it will be convenient to recall the anatomical differences between the two subfamilies. The Pineae are characterized by the presence of resin ducts in the woody and cortical tissues of their stems and roots. There are peripheral resin ducts in the primary wood of the root and similar ducts are in some cases found in the primary wood of the stem. The integument of the ovule is relatively thin and the scales of the cone are not deciduous. In the Abieteae on the other hand, resin canals are

entirely absent in the woody tissues of the stem. The only exception to this rule is their occasional occurrence in the wood of the reproductive axis (species of Abies) and in the first annual ring of vigorous branches in mature trees (species of Abies). Resin ducts occur normally and without exception in this group in the center of the primary wood of the root. Resin canals are also present in the cortex but in the genera Tsuga and Pseudolarix the cortical canals are confined to the reproductive organs and to the leaves. In the Abieteae the integument of the ovule is relatively thick, and the cone scales are usually deciduous.

As a further preliminary to the discussion of the phylogeny of the Abietineae attention must be called to certain principles or canons of comparative anatomy, derived from the study of living and fossil plants, which are of such recent origin that they have scarcely as yet been definitely formulated. One of the most important of these canons is, that ancestral structures are apt to linger on in the reproductive axes after they have disappeared from the vegetative organs. Solms-Laubach ('90) first called attention to this principle in the matter of the arrangement of the bundles in the cones of the Cycads, which is much simpler in the reproductive axis than in the vegetative stem, and according to his view is archaic. The most important contribution to this generalization, however, has been made by Scott ('97). He pointed out that in certain Cycads there are present, in the axis of the cone, mesarch bundles comparable to those found in the vegetative axes of certain of the fossil and ancestral Cycadofilices. He draws the inference that the mesarch type of bundle is primitive for the Cycads and has lingered on in certain instances as an anatomical feature of the male and female cones. The present writer ('99) has directed attention to the fact that the course of the fibrovascular bundles in the cones of the more modern Calamites is the same as that found in both vegetative and reproductive axes of the more ancient Calamites included in the genus Archaeocalamites; for in the latter there is no alternation of the course of the bundles at the nodes, a feature retained in the cones of the later Calamites and to some extent even in the modern Equisetum. In the younger stages of the development of the fibrovascular bundles of the cone in Equisetum there is present a cambium, another point of resemblance to the Calamites, ancient and less ancient, which were characterized by the presence of very marked secondary woody growth. In this connection it may be pointed out that Cushman ('03) has noted the resemblance of the leaves occurring on the reproductive axis of certain higher plants to those first appearing in the seedlings. Jackson ('99) had previously shown that the nepionic or earlier leaves of phaenogamous seedlings in many cases present remarkable resemblance to the leaves of allied fossil species. These illustrations will serve to indicate that there is a strong tendency towards the retention of ancestral characteristics in the reproductive axes of vascular plants.

Persistent as ancestral characters are in the reproductive axis, they are much more markedly so in the foliar organs. In the case of the Cycads, the fibrovascular bundles of the leaves are of the old quasi-cryptogamic mesarch type found in the medullary crown of the vegetative stem of Lyginodendron and others of the transitional Gymnosperms. We thus find living on in the leaf, a type of bundle which in the Cycads has long disappeared in the vegetative stem and occurs only in rare instances even in the more conservative reproductive axis (Scott, '97). A similar feature is presented by the leaf bundles of Lyginodendreae (Williamson and Scott, '95) and the Osmundaceae (Faull, :01; Jeffrey, :02), for in these groups the concentric Filicinean type of fibrovascular strand, which has almost disappeared in the fibrovascular zone of the stem, persists, often in full vigor, in the leaves. It has further been shown by Jackson ('99) that the outward form of the earlier or nepionic leaves of many Angiospermous and Coniferous seedlings presents striking resemblances to the adult leaves of extinct fossil species. Numerous other examples and illustrations of the same principle might be cited, but the foregoing have been chosen because they are particularly convincing on account of their confirmation by fossil data.

Lastly, in this connection we come to the ancestral features presented by the seedling. It is a recognized principle in the embryology of animals that ancestral features are apt to persist in the earlier stages even where they have quite disappeared in the adult. As a striking illustration of this principle may be cited the fact that gill slits are found in the embryos of all the great groups of the Vertebrata, although gills have long disappeared in the adult of most of the classes of the phylum. In the case of plants, as has been pointed out by Scott ('96), this feature is much less marked, but striking examples of recapitulation in the case of seedlings have been described by Strasburger ('72), Goebel ('89, date of part), Jackson, and others. The Cupressineae present particularly good illustrations of this principle, since in them the older stem has undergone very marked xerophytic modifications in the way of flattened, appressed leaves, etc. These extreme xerophytic features are absent as a rule in the seedling, where a somewhat Taxodineous type of foliage is often found. The more ancestral type of foliage may further be discovered in the relatively more vigorous main axes, where there is often present a larger and less appressed type of leaf. In this connection may be mentioned the reversion to ancestral conditions of internal structure, which sometimes occurs in the first annual ring of vigorous branches. The writer has pointed out in the first memoir of this series (Jeffrey, :03) that in the more vigorous ramifications of the cone-bearing shoots of *Sequoia gigantea* there occur, *in the first annual ring only*, resin canals such as are found as an unfailing structural feature of the wood in

the female cone. This feature is the more remarkable since resin canals are absent ordinarily in the woody tissues of the Sequoias and are replaced by resin cells of the usual Cupressineous type. This characteristic of the first annual ring of vigorous branches of mature trees of *Sequoia gigantea* must apparently be interpreted as ancestral, since it is paralleled by the presence of a similar feature in the reproductive axis.[1] The condition of reduction from a more luxuriant ancestry also explains why the resin canals in question are not found in the seedling in the first annual ring. Apparently there must be a considerable accumulation of nutritive capital before the species under discussion is able to reproduce the ancestral conditions even in the first annual ring. It may be set down then as a rule, which in the future will doubtless receive numerous exemplifications, that in forms which have clearly suffered vegetative reduction the reappearance of ancestral conditions may be delayed to the first annual ring of the more vigorous shoots of the adult.

A further general principle of comparative anatomy, which is beginning to be established, is that ancestral conditions may be recalled by appropriate experimental conditions Where there has been reduction from a more luxuriant ancestral type, experimental conditions, which bring about a greater determination of nutrition to the parts in question are apt to cause a reversion to the ancestral structure. It has been shown by Jackson ('99) that this is often true of the external form. In the case of Sequoia, as I have pointed out in the first memoir of this series (Jeffrey, '03), injuries to the phloem and the cambium, which bring about a damming up of the products of assimilation in the region of the injury, cause a hypertrophy of the woody tissues. In this hypertrophied wood more or less typical resin canals occur, similar to those found in the first annual ring of certain branches and invariably in the woody tissues of the female cone of *S. gigantea*. It is apparent that experimental morphology is likely in the near future, to receive from botanists the same attention that it has already begun to enjoy in the hands of the zoologists.

The phylogeny of the Abietineae.— The enunciation of general principles briefly attempted in the foregoing paragraphs will serve a useful purpose in the discussion of the phylogenetic relationships of the Pineae and Abieteae. In the latter group, it has been noted in the descriptive part of the present memoir that resin canals are generally absent from the woody tissues of the root and shoot. Exceptions to this statement occur in the following cases. In the genus Abies, resin ducts have been found in the wood of the cones of *A. grandis*, *A. magnifica*, and *A. apollinis*. In *A. magnifica* (as in *Sequoia gigantea*) these are also in the first annual ring only of vigorous vegetative branches of mature trees. Resin ducts also are found invariably in the primary wood

[1] Radais ('94) has also noticed this feature of the cone in *S. gigantea*.

of the first annual ring of the root. The resin canals present under the conditions described above are perfectly normal, and are surrounded by a continuous jacket of resiniparous epithelium. A further mode of occurrence of resin canals in Abies is that seen in the case of injury to the bast and cambium, either from mechanical causes, or by the attack of parasitic fungi. The resin canals formed under these conditions are generally confined to the wood, and occur as tangential rows of so called "imperfect canals," which are in full communication with each other tangentially, and thus serve to pour resin over the surface of the wound. The resiniparous epithelium in this case is ordinarily thick walled and as a consequence conspicuously pitted. The thickening of the wall seems to be merely a mechanical device, as all parenchyma of the wood is more or less characterized by this feature in the vicinity of a wound. Further, the resiniparous cells surrounding the traumatic resin ducts under consideration are apt to partake of the general features of the parenchyma normally occurring in the wood and the medullary rays. They may often as a consequence contain the globules of tanniniferous material, which are so constant a characteristic of the so called resin cells in Abies and other genera of the Abieteae as limited above. In the remaining genera, Cedrus, Pseudolarix, and Tsuga, the normal occurrence of ligneous resin canals is confined to the first annual ring of the root. Traumatic resin ducts are found in the last mentioned genera as a feature of the wood in the case of injury just as in Abies. It is of importance to note, that in Cedrus, traumatic resin canals may occur both in the horizontal and in the vertical planes, with correlation between the two systems. Only vertical ducts have been made out in the other genera of the Abieteae.

Before going on to discuss the significance of the structural features of the wood summarized in the foregoing paragraph we may turn our attention to the distribution of cortical resin canals in the Abieteae. In Abies and Cedrus, resin canals occur abundantly in the cortex of both vegetative and reproductive axes and in the mesophyll of the leaves as well. In Pseudolarix and Tsuga on the other hand, the resin canals of the cortex are strictly confined to the female reproductive axis together with its appendages and to the mesophyll of the leaves. Cortical resin ducts cannot be produced as the result of injury.

The distribution of the resin canals in the wood and cortex of the Abieteae is such that if the validity of the general principles enunciated above be admitted, we must regard them as having come from ancestors having resin canals throughout their wood and cortex, as is the case with the genera included in this memoir in the subfamily Pineae. The resin canals in the Abieteae have almost entirely disappeared in the woody tissues, only retaining their place in an isolated fashion in such conservative regions as the wood of the female cone and the first annual ring of the root and shoot. They further show their vestigial character in the phenomena of injury. In the cortical tissues there

is a close parallelism of distribution, for in Tsuga and Pseudolarix, in which cortical resin passages are largely obsolete, they persist in the ancestral situations presented by the cortex of the female cone and its appendages, and the mesophyll of the leaf. If the general principles of comparative anatomy enunciated at the beginning of this discussion are correctly formulated the Abieteae have come from a stock characterized by the presence in both fundamental and fibrovascular tissues of resin ducts which form a continuous system of horizontal and vertical canals, such as are found in the living Pineae.

If we attempt to picture to ourselves the probable course of evolution which has led to the more or less complete loss of the resin canals in the Abieteae (as defined above), it would appear to be as follows. The ancestral forms provided with a comprehensive and freely anastomosing system of resin canals in both cortical and ligneous tissues, were thus safeguarded against infection in case of injury, but at great cost both in the large supply of resinous secretion necessary to supply the needs of this extensive system, and in the large quantity expended in sterilizing a wound. On account of the reduced foliage of even the Abietineous Conifers, this was a very serious drain on the assimilatory apparatus. Gradually the more economical tendency arose of forming resin passages in the case of need only. In Pinus this tendency is scarcely observable, while in the other three genera of the Pineae it has become quite marked. In the Abieteae it has passed beyond the stage even of a marked tendency and has become the rule, so that in this subfamily the original extensive and anastomosing system of resin canals has become reduced to isolated and uncommunicating ducts, quite useless as a rule from the protective standpoint and persisting as ancestral relics in the more conservative organs and parts of the plant. The place of this system is taken by the much less costly expedient of resin cells and by traumatic resin ducts which are formed in case of need only.

It should be pointed out here, although this matter is reserved for fuller discussion in connection with the study of the genus Pinus in a subsequent memoir, that this conclusion is supported by other anatomical considerations. A characteristic feature of structure in the medullary rays of many of the Abietineae is the presence of marginal tracheidal cells, generally interpreted as favoring the radial movement of water in the wood and rendered necessary by the fact that the pits of the tracheids of the wood are mainly on the radial walls, thus providing for a tangential rather than a radial movement of water. These marginal tracheidal cells are well marked in the genera Pinus, Picea, Larix, and Pseudotsuga, but as has been recently noted by Strasburger are much less prominent in Tsuga and Cedrus, while as was long ago pointed out by De Bary, in Abies they are lacking except in a few species. My own observations in the case of Pseudolarix show them to be absent here, although I have not had access to sufficiently robust stems to be able to state positively that they are never present in this monotypic genus.

Penhallow (:03) assumes that the occurrence of these ray tracheids marks a high stage of evolution in the genera which are characterized by their presence. It should be remembered in this connection, as Strasburger ('72) has emphasized, that the Coniferales are a group which has undergone regressive metamorphosis and as a consequence structural features of high complexity are more apt to be characteristic of the ancestral forms than of those of more modern origin. Further, Penhallow (:03) himself has called attention to the fact of the sporadic occurrence of ray tracheids in the genera Juniperus (*J. communis*, var. *alpina*) and Cupressus (*C. thyoides* and *nootkatensis*) among the Cupressineae. Their presence here is to be interpreted rather as vestigial than rudimentary especially in view of the peculiarities of the seedlings in this group, which seem to show clearly that it is a reduced order of the Coniferales. Furthermore, the occurrence of ray tracheids is in itself by no means an indication that the Abietineae are a modern order, for the same feature was present in that very ancient family, the Lepidodendraceae, which, as has been pointed out by Corda (Williamson, '81, p. 294) and Scott (:00), was characterized by the presence of scalariform tracheids in the medullary rays.

We may now pass on to consider the closer affinities of the several genera of the Abietineae. As has been pointed out above they fall naturally into two series as a result of the consideration both of their anatomy and of their reproductive organs. The genus Pinus appears to stand by itself among the Pineae, for its fascicled leaves and altogether unique cones, as well as its great geological age, separate it clearly from the other three genera. Picea and Pseudotsuga seem to be rather close to one another, but Larix cannot be regarded as far removed. The genus Abies includes perhaps the greatest number of primitive features among the Abieteae. Closely allied to it is Pseudolarix, not only in its anatomical structure and its rapidly deciduous cone scales but also in its thickly integumented seeds. The deciduous foliage of Pseudolarix is by no means sufficient to unite it with Larix, as is generally assumed by the taxonomist, for Cedrus, which has always been regarded as possessing close affinities with Abies, is also occasionally deciduous, as has been pointed out by Carrière and Kent (:00). Abies and Pseudolarix closely resemble each other in the possession of very characteristic mucilage cells, which are quite absent in Cedrus and Tsuga. Cedrus is generally conceded to be allied to Abies, to which, as has been shown above, it presents a very close resemblance in the details of its anatomy, the structure of its seeds, and the deciduousness of its cone scales. It differs from Abies and Pseudolarix in the absence of mucilage cells. Of the four genera of the Abieteae, Tsuga shows the least affinity with the others. Its cone scales are not deciduous and its seeds are not relatively as thick walled as those of the three first mentioned genera. Further, in the single resin canal of the leaf, it resembles many of the Cupressineae.

Relationship of the Abietineae to other Coniferous orders. — It is perhaps the prevailing tendency at the present time to regard the Abietineae as the most modern of the Coniferous orders. This view does not appear to be supported, however, by the recent results of palaeontological research, or by those of anatomy and general morphology. It has been recently shown by Zeiller (:**04**) that Pinus, which is often regarded as a very modern representative of the Conifers, was already present in the Jurassic in the two sections representative of the hard (Pinaster) and the soft (Strobus) pines. By this discovery the genus appears as a very ancient one, for if its two distinctive sections were already well marked as early as the Jurassic period, its primitive history must lie far in the geological past, extending perhaps to the Permian, for Penhallow (:**00**) has described a Pityoxylon of this age.

In discussing the relationship of the Abietineae to the other Coniferous orders, it will be convenient at the present time to confine our attention to the Cupressineae, in the larger sense, for these have already been touched on in the first memoir. As has been pointed out by Zeiller (:**00**), the Cupressineae are relatively modern in their appearance in the geological strata, and it may accordingly be suggested as probable that they are less primitive than the Abietineae. Anatomically the wood of the Cupressineae is characterized by the absence of resin canals, except in certain sporadic instances, and the place of these is taken by resin cells. By a course of reasoning similar to that adopted in the present memoir, the writer has reached the conclusion that the resin ducts described by him in the first annual ring of branches and in the wood of the cone-axis and scales of Sequoia are an ancestral feature. This conclusion was fortified by the occurrence of resin canals in this genus as the result of injury, and presumably as a reversion to the ancestral condition of the wood. The inference was drawn in the first memoir that the presence of what were apparently vestigial resin canals in Sequoia pointed to the derivation of that genus from a stock characterized by the presence of ligneous resin canals. The attempt has been made in the present memoir to show that this condition of the wood is not only characteristic of the Abietineae, but is also a very old one for this order. On the basis of wood structure alone it would appear that the Abietineae are older than the Cupressineae. It is obviously undesirable to interpret affinities from the structure of the wood alone, useful as this has proved in tracing affinities in the case of fossils, where no other evidence has been available.

The structure of the female cone is universally admitted to be of great importance in arriving at the relationship of the various orders of the Coniferales. There are several morphological interpretations of the female cone, the best established of which explains it as a main axis bearing a number of flattened and reduced ovuliferous shoots, each borne in the most primitive condition, in the axil of a bract. In the

less primitive types of female cone the bract and flattened axis become more or less completely fused with each other, so that in many cases it is only possible to distinguish them by their still separate fibrovascular supply. This view has received strong confirmation. As is well known, in the genus Sciadopitys the apparent vegetative leaves are really two fused leaves belonging to an abortive branch and are axillary to a scale-like bract. This interpretation is generally accepted in the case of the genus under discussion, and as has recently been pointed out with great aptness by Coulter (:01) is a clear case of parallel reduction in a vegetative shoot corresponding to that hypothetically found in the case of the ovule-bearing scales of the Coniferous cone. This parallel drawn by Professor Coulter receives the strongest confirmation from proliferous female cones of Sciadopitys, in which the ovuliferous scales are actually replaced by green double needles, such as are found on the vegetative axes of the same species (for a good original figure of one of these interesting proliferous cones, see Veitch's Manual of the Coniferae, 1900, p. 54). A shoot organ has appeared so often and in so many different genera of the Coniferales in place of the ovuliferous scale, that we may safely regard the two structures as homologous. If it be admitted that the ovuliferous scale is the representative of a reduced shoot occurring in the axil of a bract-like leaf, it follows, other things being equal, that the group which most nearly realizes the ancestral condition will be the most primitive, and those in which the bract and ovuliferous scale are wholly or partially fused must be more modern and specialized. On this basis we are compelled to regard the Abietineae, in which the bract is without exception quite free from the ovuliferous scale, as more primitive than the Cupressineae (in the large sense) in which the bract and ovuliferous scale are always intimately fused together.

But it is not in the structure of the female cone alone that the Abietineae appear to show themselves more primitive than the Cupressineae. The prothallium found in the ovule of this order is throughout characterized by the thick megaspore coat which surrounds it. This is a feature which the Abietineae possess in common with the Cycads and the fossil Gymnosperms. The thick coat surrounding the megaspore in the Cycads has been described by Warming and more recently by Lang. The figures of Williamson, Scott, and Oliver sufficiently establish the presence of a similar thick megaspore coat in several fossil Gymnosperms. In the Cupressineae, the Taxineae, the Gnetales, etc., the coat surrounding the megaspore is thin or obsolete. The Abietineae thus present in the structure of their megaspore coat a very significant feature of resemblance to the older Gymnosperms.

The structure of the male gametophyte in the Abietineae is also indicative of their being more primitive and less reduced than the Cupressineae. In the first

order two or three prothallial cells are formed within the germinating pollen grain previous to anthesis, as has been shown by Strasburger and others in the case of Larix, Pinus, Tsuga, etc. In the Cupressineae, using the term in the broader sense to include such forms as Sequoia and Taxodium as well as Thuja, Cupressus, and Juniperus, this is not the case as only the stalk and antheridial cells and the tube nucleus make their appearance in the germinating microspore. It may be urged that the winged pollen, found in Pinus, Abies, Cedrus, Picea, etc., is to be regarded as a mark of high specialization and as a consequence an indication of a modern origin for the group under discussion. This is by no means necessarily the case, for examples of winged microspores are known to have existed among the Lepidodendrids (Scott, '98), and there are no cases of winged pollen grains among anemophilous Angiosperms, which may be taken as the most modern type of wind-fertilized vascular plants. It seems probable that the air sacs are for the purpose of reducing the specific gravity of the ancestrally heavy and multicellular type of pollen grain found in the Abietineae.

Perhaps the most important indication of the primitive nature of the Abietineae is supplied by the study of their leaf trace. It is now a well established general principle that ancestral features are apt to persist for a long time in the vegetative leaves of the vascular plants. This principle is, for example, very well illustrated by the case of the Cycads, referred to in an earlier paragraph. Attention has been called in the descriptive part of this memoir to the fact that no matter what may be the character of the foliar strand in the lamina of the leaf in the Abietineae, it is always a double strand in the cortex. A double leaf trace was characteristic of Lyginodendron, Poroxylon, Calamopitys, the Cordaites, and others of the fossil and transitional Gymnosperms. It is also exemplified in the foliar trace of Ginkgo and in the double strand, which often passes off to the sporophylls in the Cycads. Scott (:00) has called attention to this feature of the older Gymnosperms and suggests that it may have a taxonomic value. In view of the facts described in this memoir for the Abietineae, the double trace appears to have a peculiar significance, especially when it is recalled that the Cupressineae have but a single foliar strand (Bertrand, '74). The topography of the double foliar trace in the Abietineae is such that we may regard the single leaf trace, which is found in what we believe to be the less ancient orders of the Coniferales, *i. e.*, the Cupressineae, Taxineae, etc., as originating by the progressive reduction in size of the leaves. The process is centripetal, that is, it progresses from the apex of the leaf downwards into the cortex of the stem, so that starting with a single bundle in the foliar apex we arrive sooner or later at the primitive double bundle. The separation may take place high up in the lamina of the leaf, as has been pointed out by Strasburger ('91) in the case of Pinus. Further, in very small leaves of the Abietineae, as has been noticed

by Thomas ('66), there may be but a single strand throughout. This author is of the opinion that the single bundle is more primitive, and cites Ginkgo as an example in which the increased development of the leaf leads to the appearance of a double foliar trace. With our present knowledge of the more ancient and especially of the fossil Gymnosperms, this interpretation cannot be accepted, for we have now every reason to believe that the ancestors of the Coniferales had much larger foliar organs, much more richly supplied with strands of fibrovascular tissue, than their descendants. The progression is consequently in the opposite direction, *i. e.*, the more modern Gymnosperms have suffered reduction both in leaf surface and in the fibrovascular tissue constituting the leaf traces. The simplification of the leaf traces into a single strand has apparently been from above downwards. In further support of this view may be cited the observation made by Scott ('97) in the case of the reduced strands occurring in the pedunculer portion of the cone in certain species of Cycads. Here paired strands coming off from the central cylinder of the cone, run a greater or less distance upward into the cortex and then become fused together. Dr. Scott considers it probable that these double strands represent abortive leaves. It is interesting in connection with the present argument that there should be the same fusion of originally separate leaf traces at the apex in the case of reduction.

Other indications of primitive affinity, less important it is true, because less wide spread and constant, are the occurrence of a chambered pith in Abies and in certain species of Pinus, and in the case of the leaf trace of the former genus, the complete enclosure of the phloem of the laminar bundle of the leaf in certain instances, by a cordon of transfusion tissue. The first of these features was very prevalent in the Cordaites although not universally present (Scott, :02), while the second has also been recently described in a Cordaitean leaf (Stopes, :03).

If the arguments advanced in the foregoing paragraphs are sound, we may assume, because they present many features of structure which unite them both with the older Gymnosperms on the one hand, and by an obvious process of reduction, with the Cupressineae, etc., on the other hand, that the Abietineae are a very ancient family or order of the Coniferales. This conclusion is favored by what is known at the present time of their geological occurrence, and will probably receive fuller confirmation from this source when the geological record is more complete than it is at the present time.

The affinity of the Abietineae with other cohorts of Gymnosperms.—The discussion of the relationship of the Abietineae with other great groups of Gymnosperms has been largely anticipated in the paragraphs of the last section. Both Coulter and Chamberlain (:01) and Scott (:00) among recent writers on the subject of the phylogeny of the Gymnosperms have derived the Coniferales as a whole from a Cordaitean stock or plexus

The results of the present investigation seem only to add confirmation to this view. Although the reproductive apparatus of the Cordaites, as far as we are at present acquainted with it, was somewhat different in its organization from that of the Coniferales, still as Dr. Scott (:00) has pointed out in the case of the female axis, it is not difficult to trace homologies with that of the latter group, if we regard the ovuliferous apparatus in the Conifers as consisting of a reduced and modified axillary shoot. The anatomical study of the vegetative organs of the Coniferales, as represented in the present instance by the Abietineae, serves strongly to confirm the relationship of the two groups. It seems quite impossible to refer the Coniferales any longer to a Lycopodineous ancestry, although their superficial features seem somewhat to favor such a derivation. It has been pointed out by the writer (:02) that the mode of exit of the leaf trace from the central cylinder, even in those Conifers which have their foliage most reduced, is distinctly Filicinean, and of a type which is never found in the Lycopods or their allies. The present research increases the difficulty of the Lycopodineous phylogeny, by making clear that the foliar fibrovascular supply in the case of the Abietineae is of the same double type as that which is primitive for the Lyginodendreae, the Cordaitales, the Cycadales, the Ginkgoales, and many Filicales.

Summary.

1. The Abietineae are divisible, on the evidence supplied by a study of their vegetative and reproductive organs, into two very distinct subfamilies, *viz.*, the Pineae and the Abieteae.

2. The Pineae are characterized by the invariable presence of resin canals, forming an anastomosing system in the secondary wood and cortex of root and shoot. Resin canals are present in the outer margin of the primary wood of the root. The scales of the female cone are not deciduous. Pinus, Picea, Larix, Pseudotsuga.

3. The Abieteae ordinarily do not possess resin canals in the secondary wood of root and shoot. Resin canals, however, are sometimes found in the wood of the female reproductive axis, and in the first annual ring of vigorous shoots of sexually mature trees. Resin canals occur in the secondary wood in tangential rows, as a result of injury. Resin canals are invariably found in the center of the primary wood of the root. The scales of the female cone are generally deciduous. Abies, Pseudolarix, Cedrus, Tsuga.

4. The evidence derived from anatomy and experimental morphology goes to show that the presence of resin ducts in the woody tissues and in the cortex of the Abietineae is primitive for the group. The resin canals persist longest in the reproductive axis, the leaf, and the *first* annual ring of root and shoot. In the more specialized genera the resin canals of the wood are replaced by resin cells, but in the latter condition

of the wood, resin canals may always be recalled as a result of injury. The disappearance of resin canals and their replacement by resin cells is probably for the sake of economy of carbo-hydrate material. In Pseudolarix and Tsuga even the cortical resin canals disappear from all organs except the female reproductive axis, together with its appendages, and the vegetative leaf.

5. The Abietineae are an older group than the Cupressineae, in the larger sense, and are either antecedent to these or from the same ancestry. This conclusion is reached from an anatomical and experimental morphological study of their organs, root, shoot, and leaf. It is confirmed by the examination of the female reproductive organs and of the pollen. It is further in conformity with palaeontological evidence.

6. The Abietineae are throughout characterized by the same double leaf trace which is a constant feature of the older Gymnosperms, the Lyginodendreae, the Cordaitales, the Ginkgoales, and the Cycadales. This feature serves to separate them from the Cupressineae in the larger sense, and to unite them with the Cordaitales, which they resemble in other important particulars, described in the body of the memoir.

7. The Abietineae must be regarded on comparative anatomical and morphological grounds as a very ancient order of the Coniferales, and may even be the oldest living representatives of this group.

In conclusion, I wish to express my obligation to Prof. G. L. Goodale for access to the specimens of wood in the economic collections of the Museum. I am indebted to my father for material collected during his summer vacation. My thanks are also due to Mr. George S. Shaw, former chairman of the visiting committee to the Museum, and through him to Prof. C. S. Sargent and Mr. Jackson Dawson of the Arnold arboretum of Harvard university, and to Mr. Walter Hunnewell, the present owner of the Hunnewell pinetum. But for the kindness of Mr. Shaw and those he has interested in my needs, this work could scarcely have been carried to a conclusion. A considerable amount of valuable material has reached me from the authorities of the Royal gardens, Kew, England, for which I likewise wish to offer my sincere thanks.

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Explanation of Plates.

(All the figures are from photomicrographs.)

PLATE 1.

Fig. 1. Transverse section through the margin of the traumatic wood in *Pseudotsuga taxifolia*. × 20.

Fig. 2. Transverse section of the root of *P. taxifolia*. × 20.

Fig. 3. Transverse section of the lower third of the leaf of *P. taxifolia*. × 40.

Fig. 4. Transverse section of a stem of *P. taxifolia*, showing the exit of the leaf trace from the central cylinder. × 60

Fig. 5. Transverse section of the stem of *P. taxifolia*, showing the structure of the leaf trace in its passage through the cortex. × 60.

Fig. 6. Transverse section of the root of *Larix americana*, showing the communication of the resin ducts, opposite the groups of protoxylem, with the ducts of the cortex. × 60.

Fig. 7. Transverse section through the leaf base of *L. americana*, showing the double trace. × 60.

Fig. 8. Transverse section through part of a wounded stem of *Picea nigra*, showing the formation of traumatic resin canals. × 10.

PLATE 2.

Fig. 9. Transverse section of the stem of *Picea nigra*, showing the double leaf trace. × 60.

Fig. 10. Transverse section of a wounded stem of *Abies balsamea*, showing the formation of traumatic resin canals along the margin of the wood. × 8.

Fig. 11. Part of the same more highly magnified to show the details of the resin canals. × 30.

Fig. 12. Traumatic wood of the base of a witches' broom of *A. balsamea*, showing the formation of resin canals. × 30.

Fig. 13. Section of the injured wood of the stem of *A. magnifica*, showing the formation of numerous rows of resin canals in the same annual ring. × 60.

Fig. 14. Transverse section through the upper part of the axis of the cone of *A. magnifica*, showing the presence of normal resin canals in this organ. × 20.

Fig. 15. Section through part of the lower region of the cone-axis of *A. magnifica*, showing the smaller size of the resin canals. × 30.

Fig. 16. Section through part of the same region as that shown in Fig. 14 more highly magnified to show the fusion of the resin canals. × 40.

PLATE 3.

Fig. 17. Section through a vigorous branch in the reproductive region of *Abies magnifica*, showing the presence of normal resin canals in the first annual ring. × 20.

Fig. 18. Section through another specimen more highly magnified to show the normal occurrence of resin canals in the first annual ring. × 20.

Fig. 19. Section through a vigorous yearling branch of *A. magnifica*, showing the presence of normal resin canals. × 20.

Fig. 20. Transverse section of the inner portion of the last, highly magnified to show the structure of the resin canals. × 180.

Fig. 21. Longitudinal section of the pith of *A. magnifica*, showing the presence of sclerified diaphragms similar to those of the Cordaites. × 25.

Fig. 22. Transverse section of a root of *A. nobilis*, showing the median resin duct of the primary wood. × 15.

Fig. 23. Transverse section of the leaf trace of *A. magnifica*, showing the packet of tracheids surrounding the phloem. × 150.

Fig. 24. Transverse section of the cone-axis of *A. appolinis* showing the presence of normal resin canals. × 20.

PLATE 4.

Fig. 25. Part of the last more highly magnified. × 40.

Fig. 26. Section of a wounded branch of Pseudolarix. × 8.

Fig. 27. Part of the same more highly magnified, to show the presence of traumatic resin ducts. × 40.

Fig. 28. Section of the root of Pseudolarix, to show the median resin canal. × 20.

Fig. 29. Part of another root more highly magnified. × 30.

Fig. 30. A wounded root of Pseudolarix. × 20.

Fig. 31. Transverse section of a branch of Pseudolarix. × 15.

Fig. 32. Transverse section of the peduncle of a female cone of Pseudolarix. × 20.

PLATE 5.

Fig. 33. Section of a portion of the axis of the female cone of Pseudolarix, showing the presence of normal resin canals. × 30.

Fig. 34. Section through the base of the ovuliferous scale and the sterile bract of Pseudolarix. × 20.

Fig. 35. Section through the sterile bract of the same. × 40.

Fig. 36. Section through the foliage leaf of Pseudolarix. × 40.

Fig. 37. Section through traumatic wood of *Cedrus atlantica*. × 20.

Fig. 38. Section through the wounded root of the same. × 20.

Fig. 39. Resin canals of the same more highly magnified. × 180.

Fig. 40. Section through the wood of *C. deodara*, showing the presence of both horizontal and vertical resin canals × 20.

PLATE 6.

Fig. 41. Another section more highly magnified. × 70.

Fig. 42. Longitudinal section of wood of the same, showing horizontal and vertical resin canals. × 15.

Fig. 43. Another of the same. × 43.

Fig. 44. A tangential section of the same, showing resin canals of various degrees of development in transverse section. × 20.

Fig. 45. Section of cone of *Cedrus atlantica*, to show absence of resin ducts in the wood. × 30.

Fig. 46. Transverse section of the root of *C. atlantica*, to show median resin canal. × 20.

Fig. 47. Transverse section of the double cortical leaf trace of *C. atlantica*. × 120.

Fig. 48. Transverse section of wounded stem of *Tsuga canadensis*. × 10.

PLATE 7.

Fig. 49. Transverse section of a vigorous yearling stem of *Tsuga mertensiana*. × 20.

Fig. 50. Transverse section through part of the cone of the same. × 25.

Fig. 51. Transverse section of the axis of the cone, *T. canadensis*. × 25.

Fig. 52. Transverse section of root of *T. mertensiana*. × 20.

Fig. 53. Transverse section of root of *T. canadensis*. × 50.

Fig. 54. Transverse section of part of a wounded root of *T. canadensis*. × 30.

Fig. 55. Transverse section of center of root of the same. × 180.

Fig. 56. Transverse section of stem of the same showing double leaf trace. × 40.

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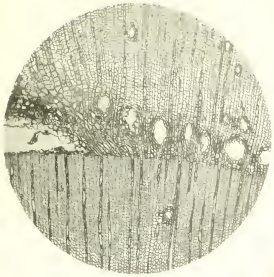

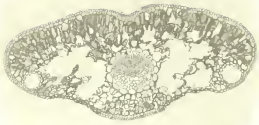

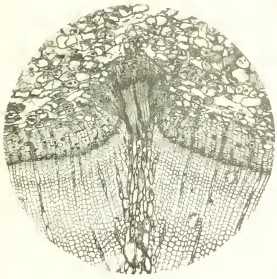

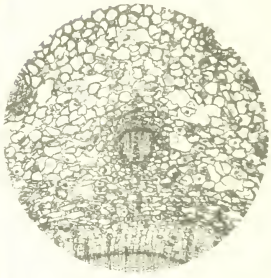

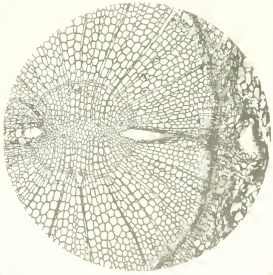

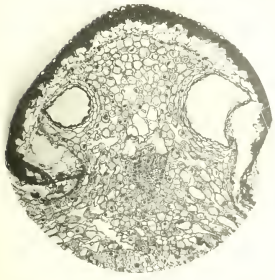

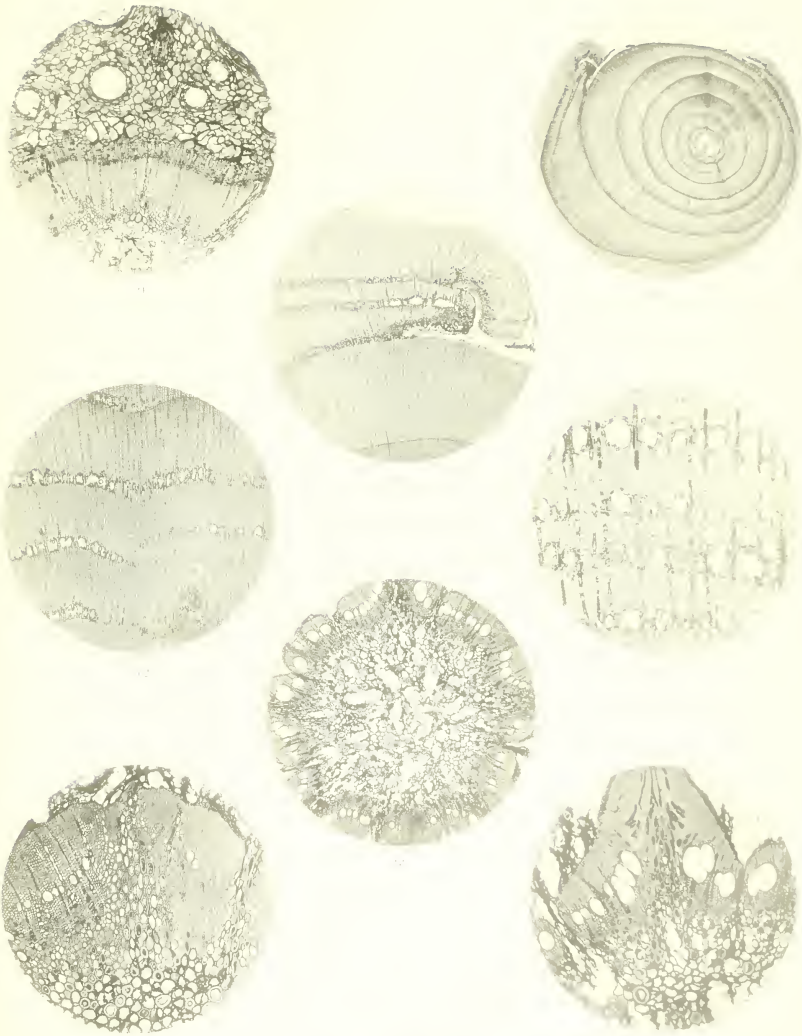

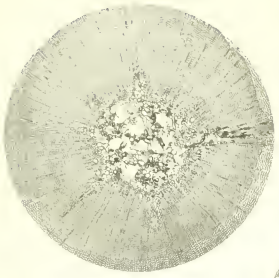

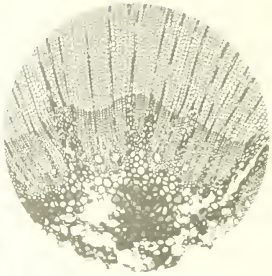

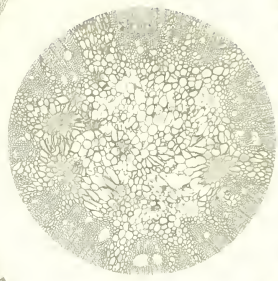

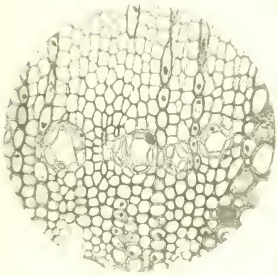

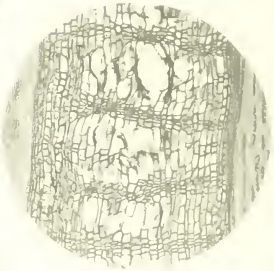

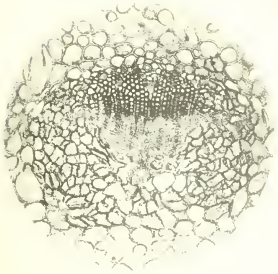

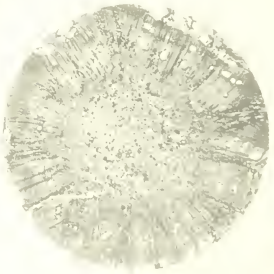

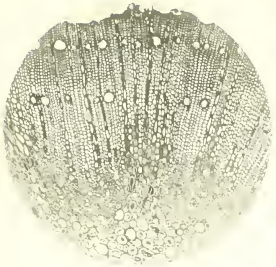

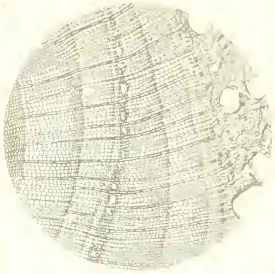

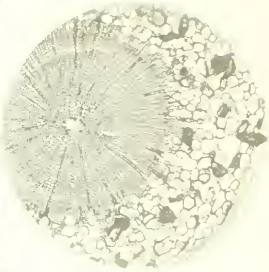
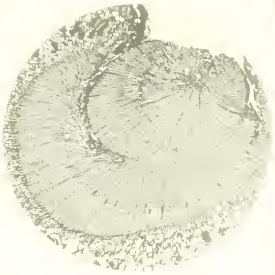
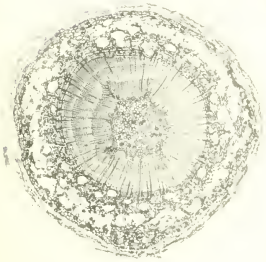
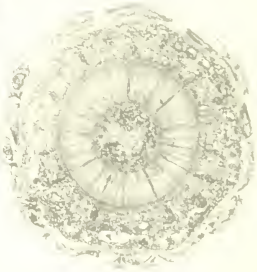

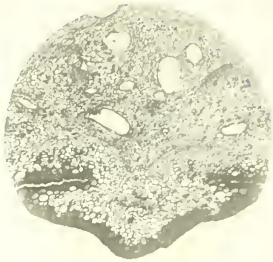

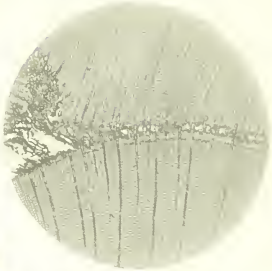

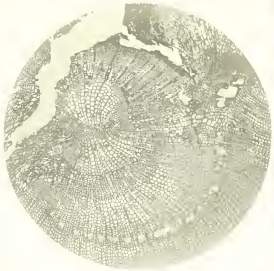

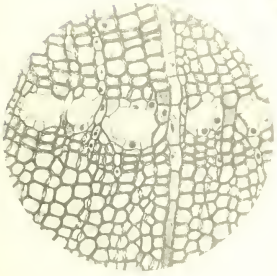

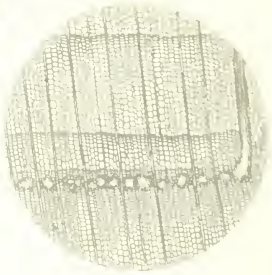

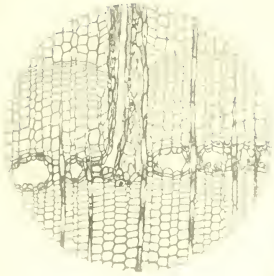

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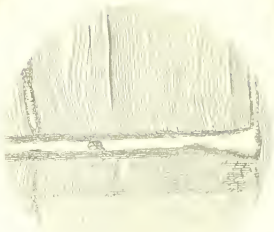

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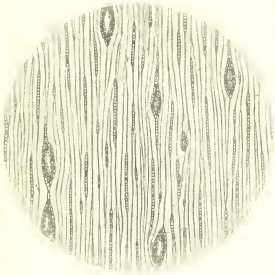

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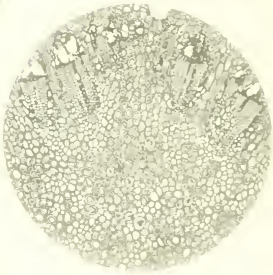

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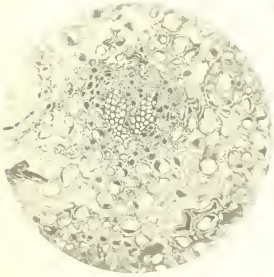

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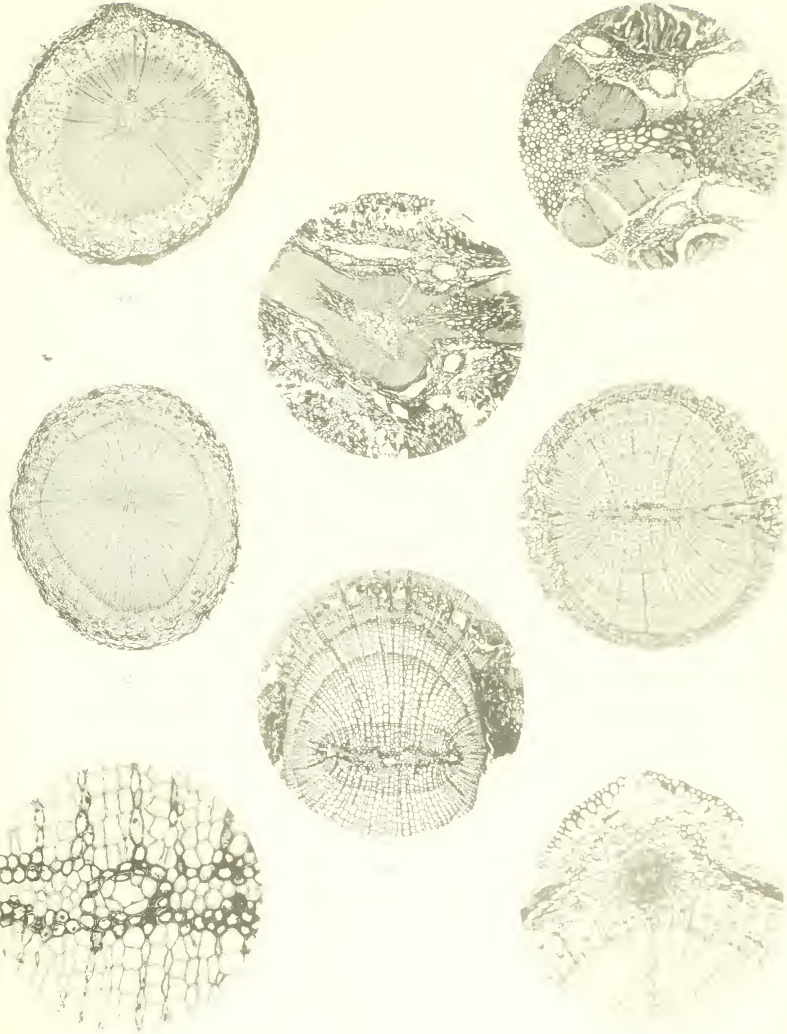

Memoirs of the Boston Society of Natural History.
Volume 6, Number 2.

THE COMPARATIVE ANATOMY AND PHYLOGENY OF THE CONIFERALES.
PART 3.—MESOZOIC AND TERTIARY CONIFEROUS WOODS.

By RAY ETHAN TORREY.

WITH EIGHT PLATES.

BOSTON:
PRINTED FOR THE SOCIETY WITH AID FROM
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April, 1923.

INTRODUCTORY AND HISTORICAL.

Fossil plants have always been a source of wonder and speculation. Widely dispersed over the earth, naturally exposed in sea-cliff and stream cutting, they early formed the basis of many strange legends some of which we find embodied in the writings of such mystical philosophers as Albertus Magnus. Like all the other natural sciences, palaeobotany passed through its encyclopaedic and systematic periods. The earlier work was necessarily concerned with impressions and other superficial structures only; there was slight basis of agreement among workers; and the early literature, though voluminous, offers little but tangled synonymy to the modern student. Extensive bibliographies have been given by Göppert (1850), Ward (1885), and Knowlton (1889).

With the introduction of the microscope a new subscience of fossil plants began to develop; namely, that of structural palaeobotany. It is a very young science, for little more than a century has elapsed since Parkinson (1820) worked out the structure of a *Psaronius* stem.

English palaeobotany, however, honors Henry Witham (1831) as its real founder. In his "Observations on Fossil Vegetables" he establishes several form-genera of fossil woods based on histological features, and although later studies have shown that Witham's genera were too broad and represented complexes of woods, yet he had initiated a science whose development in the hands of English workers is one of the great achievements of modern science. True, it does not startle the layman like radium and wireless telegraphy since an appreciation of its story demands considerable training; but we are justified in saying that it probably supplies the best proof we have of the doctrine of evolution, and that it makes of plant morphology a subject of intense and living interest.

The development of continental structural palaeobotany dates from 1841, when Göppert began his studies on the conifers. He saw clearly that for a basis of comparison he must know living species intimately and so his works dealt with both living and fossil forms. His system of classification recognized the fundamental distinction between the araucarian type of wood with its "Hoftüpfel quincuncial gestellt, meist infolge gedrängter Stellung gegenseitig abgeplattet," and the pinean type with "Hoftüpfel nicht gedrängt, und wenn mehrreihig meist gleich hochstehend." His finer separation of the pinean woods was based on the presence or absence of wood parenchyma and of resin canals.

Following in Göppert's steps came Gregor Kraus, whose work appeared in 1864, and was followed later by a classification of coniferous woods contributed to Schimper's "Traité de paléontologie végétale" (1870–72). This is an important landmark and is probably the most significant classification anterior to that of Gothan's which is subsequently to be discussed. It established several well-recognized genera and its importance justifies its quotation.

THE SYSTEM OF KRAUS.

A. Cellulae prosenchymatosae aporae ..... *Aporoxylon* (Unger).
B. Cellulae prosenchymatosae porosae.
1. Pori uniseriales distantes vel oppositi.
a. Cellulae prosenchymatosae sine spiralibus.
aa. Cellulis parenchymatosis (*viz*. wood-parenchyma) resiniferis nullis.
(*a*) Radii medullaris cellulae in sectione transversa rotundae ..... *Physematopitys* Göppert.
(*b*) Oblongae ..... { *Cedroxylon* Kraus. / *Pinites* Göppert; *Peuce* Unger.
bb. Cellulis parenchymatosis (resiniferis) creberrimis ..... *Cupressoxylon* Kraus.
Cupressinoxylon Göppert.
Thujoxylon Unger.
cc. Crebis ductibusque resiniferis ..... *Pityoxylon* Kraus.
Pinites Göppert; *Peuce* Unger.
b. Cellulae prosenchymatosae poroso-spiralis.
aa. Radiis medullaribus porosis ..... *Taxoxylon* Unger.
Taxites Göppert.
bb. Radiis medullaribus poroso-spiralibus.
Spiropitys Göppert [probably a *Pityoxylon* and the spirals do not belong to the rays].
2. Pori uniseriales contigui vel spiraliter dispositi pluriseriales.
a. Pori rotundae vel contiguitate polygoni.
aa. Radiis medullaribus simplicibus (uniserialibus) ..... *Araucar(i)oxylon* Kraus.
Araucarites Göppert.
Dadoxylon Endlicher.
bb. Radiis medullaribus compositis ..... *Pissadendron* Endlicher.
Palaeoxylon Brongniart
(probably Cycads or Cycado-filicales).
b. Pori compressi oblongi ..... *Protopitys* Göppert.

The system is not faultless. Thus the genus *Aporoxylon*, which really signifies without bordered pits on the tracheids, would certainly be a startling type of wood if it really existed. The genus was founded on a specimen whose pits had been obliterated through faulty petrifaction. "Aporoxylon" is unfortunately a very common wood and always comes to rest in the waste-basket. *Physematopitys*, founded on the rounded and swollen ray-cells, has not stood the test of later studies. *Spiropitys* and *Pissadendron*, too, have proved to be unsound.

Following Kraus's system we have the classification of Schenck which is to be found in Zittel's "Handbuch der Paleontologie."

THE SYSTEM OF GOTHAN.

The latest important addition to the classification and taxonomy of gymnospermous woods is the system of Gothan (1905). His particular contribution has been to point out the value of ray-cells as diagnostic of several new genera. We are inclined to think that some of Gothan's genera "auf ganz zu schwachen Unterscheidungs-Kennzeichnen beruhen," even as he remarked concerning questionable genera of other workers in the field. Every enthusiastic student tends to apply a helpful principle too widely, and doubtless the same criticism will be made of the classification contributed later.

Gothan's key with some modifications has been the basis of the anatomical studies of this paper. His article is difficult of access and his system is here quoted entire.

A. Hoftüpfel klein, alternierend, oben und unten abgeplattet, wenn mehrreihig, allseits (polygonal) abgeplattet. . . . . *Dadoxylon* Endlicher; *Araucarioxylon* Kraus; *Cordaioxylon* Felix; *Cordaixylon* Gr. 'Eury; *Araucarites* Göppert; *Cordaites* (div. auct.)

B. Hoftüpfel rundlich, grosser, nicht gedrängt; wenn mehrreihig meist gleichhochstehend.

1. Alle Tracheiden mit starker Spiralverdickung. . . . . *Taxoxylon* Unger; *Taxites* Göppert.
2. Tracheiden ohne diese (nur bei einigen Harzgänge führenden Abietineen solche, aber schwächer).
   a. Abietinencentüpfelung vorhanden, nur bei den grosseiporigen *Pinus*-Arten fehlend; Harzparenchym bei einigen im Spätholz, sonst fehlend.
      (1) Harzgänge, horizontale und verticale, regelmässig vorhanden.
         (a) Harzgängepithel dickwandig, verholzt; Markstrahltüpfel nicht eiporig; Spiralverdickung im Spätholz (selten auch im Frühholz); zahlreiche Tangentialtüpfel im Spätholz. Quertracheiden vorhanden, ohne Zacken. Abietinencentüpfelung sehr deutlich. *Piceoxylon* Gothan; *Pityoxylon* Kraus; *Pinites* Göppert.
         (b) Harzgängepithel dünnwandig, nur selten etwas dickwandig; Markstrahltüpfel (Frühholz) stets eiporig. Spiralverdickung im Spätholz stets fehlend, ebenso Harzparenchym. Quertracheiden mit oder ohne Zacken. Abietinencentüpfelung bei den grosseiporigen fehlend bezw. reduciert. . . . . *Pinuxylon* Gothan; *Pityoxylon* Kraus; *Pinites* Göppert.
      (2) Harzgänge fehlend, Tangentialtüpfel im Spätholz häufig. Holzparenchym bei einigen ständig am Ende des Jahresrings, bei diesen Quertracheiden vorkommend.
   b. Abietineentüpfelung fehlend, Holzparenchym ± regelmässig vorhanden.
      (1) Markstrahltüpfel cupressoid (Frühholz!)
         (a) *Juniperus*-Tüpfelung vorhanden. . . . . *Cupressinoxylon* Göppert.
         (b) Diese fehlend.
            (1a) Markstrahltüpfel glyptostroboid; gedrängt. . . . . *Glyptostroboxylon* Conwenz.
            (1b) Markstrahltüpfel ein Mittelding zwischen beiden (nur in ausgewachsenem älterem Holz typisch); gedrängt in ± grosser Anzahl auf dem Felde (oft mehr als 6).
      (2) Markstrahltüpfel podocarpoid bis typisch grosseiporig (Rest der Taxaceen). Meist nur 1-2 Tüpfel pro Kreuzungsfeld. Harzparenchym ± häufig.
         (a) Markstrahltüpfel podocarpoid bis teilweise eiporig. . . . . *Podocarpoxylon* Gothan.
         (b) Markstrahltüpfel typisch eiporig. . . . . *Phyllocladoxylon* Gothan.

In publications subsequent to the above, Gothan has set up several new genera such as *Anomaloxylon, Protocedroxylon, Protopiceoxylon* and *Thylloxylon*. Diagnoses of these are given later.

Among French contributions to coniferous xylopalaeontology should be mentioned the works of Lignier (1907). He conservatively recognizes but five types of wood: *Araucarioxylon, Cedroxylon, Pityoxylon, Cupressinoxylon,* and *Taxoxylon*. Lignier has, however, adopted a very questionable recommendation of Conwenz and of Felix (1882) and by use of the prefixes *Cormo-, Rhizo-,* and *Clado-,* attempts to differentiate between stem, root, and twig wood.

The Anomalous Development of Structural Palaeobotany.

A few words may now be said concerning the rather anomalous development of palaeobotany and the relation of the American studies to those of European workers. The development is called anomalous since, paradoxical as it may seem, we really know more about Palaeozoic plants than we do about those of the Mesozoic and early Tertiary.

From the exquisitely silicified and calcified remains of the Carboniferous vegetation we can study the histological details even to such minutiae as divisions of the apical meristems and the organization of spore tetrads in the sporocytes. But as we ascend through the rock strata into the Mesozoic all this changes. Just when a significant modernization was taking place, the remains are so scantily and so poorly preserved that they give us little more than tantalizing glimpses. The volume in which the Mesozoic history of the earth was written has fared miserably: fire and water and rough handling have destroyed the records. After all these years Darwin's "abominable mystery" of the origin of the Angiosperms remains as an irritating thorn in the botanical flesh.

One cannot resist drawing a parallel with human history. Thus, Egypt offers us a fossil record through which we enter with startling intimacy into the life of her people. The civilizations of Greece and Rome, too, are well known. But as we enter the Middle Ages—the Mesozoic and Tertiary of human history—the records become obscure and confusing. The geological and human Mesozoics were alike periods of storm and stress.

The Development of the American School of Palaeobotany.

Early Work.

In America, except in rare cases, we lack the Palaeozoic structural material so abundant in the Old World. We do, however, possess a considerable wealth of Mesozoic remains, and as a consequence American students have set themselves to the difficult task of unraveling the tangled Mesozoic record. Most of our material is in the lignitic state and progress was necessarily delayed for a long time waiting for the development of a technique to cope with such refractory stuff.

To Sir J. W. Dawson (1854) belongs the honor of first investigations on American fossil woods. The specimens which he studied were silicified trunks from Prince Edward Island, and were mostly members of the extinct gymnospermous order *Cordaitales*. For such woods we use the name *Dadoxylon*.

Dr. F. H. Knowlton (1889) continued Dawson's investigations and described many species from petrifactions. He also attempted lignitic woods but histological technique was scarcely advanced enough at the time to make the preparations particularly satisfactory.

It is to work of students at Harvard University that we owe the recent impetus to the study of fossil woods. The success attending these investigations has been intimately related to progressive perfection of the nitro-cellulose method which enables one to soften the brittle and friable lignitic specimens and to imbed them in a homogeneous matrix for sectioning. Sections

so prepared are far superior to anything yielded by petrifactions. Practically the only modifications which such woods have undergone is change in color and distortion due to pressure. Histological details, such as tracheid and ray markings, are as well preserved as in living woods.

The secret of the finest sections lies in two words: charred wood. Unmodified woody lignite is often hardly worth sectioning; its tracheids are commonly collapsed or their lumina are blocked with gummy substances; the rays are crushed and their diagnostic features obliterated.

In almost every lignite bed, however, one finds flattened trunks and branches which are covered with a charcoal film. These attest the prevalence of forest fires in the ancient days and are the specimens which repay study. The charcoal itself is not the valuable part. This should be sought in the boundary zone between charred and uncharred wood, where the modified tracheidal walls, because of their slight scorching, were rendered incapable of hydrolysis and consequently have not been swollen and crushed.

A brief historical review of the work at Harvard is now in order.

In three comprehensive papers on living conifers, Jeffrey (1903, 1905, 1912) laid a foundation for his investigations upon fossil forms even as Göppert had done in 1841. But the modern student was approaching his problem in a new way. Darwin had intervened, and research was now directed to the discovery of features which might throw light upon the phylogeny of the conifers. Certain general working principles of comparative anatomy were formulated and their application led to conclusions regarding the history of the groups of conifers that were somewhat at variance with conventional views. Arising almost as a necessity from the richness of the fossil material various new form-genera were from time to time proposed by Jeffrey or by those working with him. Thus we have *Brachyoxylon* for the wood of the well-known Cretaceous conifer *Brachyphyllum*, *Araucariopitys* for a wood with a blend of araucarian and pine characters, while the prefix "*Para*" has been used by several students for araucarian woods which superficially resemble members of the Abieteae. Thus we have *Paraceroxylon* Sinnott, *Paracupressinoxylon* Holden.

Geological and Geographical Distribution of the Lignites of the United States.

In the spring of 1917, the funds available from a Sheldon Traveling Fellowship from Harvard University made possible the extension of these investigations on the lignitic woods of the United States. Up to this time nearly all the material studied had come from the easily accessible Cretaceous deposits of the Atlantic Coastal Plain. Hence a chance to compare the fossil coniferous flora of the western United States with that of the East, to search for new and annectant forms, and to gather information concerning the ancient geographical distribution of the conifers was eagerly accepted.

The lignites of the United States present a combination of geological, botanical and economic problems. With the first two aspects we now propose to deal. Reference will be made from time to time to literature which deals with the third aspect, though this does not particularly concern us.

Definition and Description of Lignite.

The term *lignite* has been well defined by Dumble (1892). He says: "Under this name are included portions of wood—trunk, stem, leaf, or root—more or less fossilized and altered into brown coal; yellow to dark brown in color and with a fracture varying according to the character of the wood from which they were derived. It is not infrequently the case that there can be found in a single piece, woody structure and particles altered into earthy, pitch or glance coal. Lignites occur in single trunks or particles scattered through the sands, and as logs imbedded in deposits of brown coal of different varieties. Much of it, as it comes from the mine, retains its form and character so completely as to be almost indistinguishable from the ordinary wood of the present time, except that it is somewhat darker in color. It is frequently the case that such a log will be partly lignite and the remainder silicified wood. Lignite is formed principally of coniferous woods, less often of endogenous woods, peat and water plants.

"The trunks of trees which are altered into lignite are seldom found standing at the locality at which they grew; and if they are, it is in a broken condition. They are more often found in horizontal positions, generally flattened, so that their breadth is to their height as 1:3 to 1:15."

Many of the flattened trunks, as before stated, show clearly the marks of fire; they are encrusted with charcoal which often manifests the cubical fissuring so characteristic of the surface of charred boards.

Another striking feature of many lignites and one quite contrary in value to the last, is the prevalent inclusion of iron-pyrites. This seems particularly characteristic of the charred specimens; it fills the tracheids with slender glistening wires; it crystallizes out in its familiar pyritohedrons in resin canals and wound cavities; its rhaphide-like crystal-aggregates spot the naturally cleaved surfaces. It destroys the edge of the microtome knife and tries the temper of the investigator, since it cannot be removed without destructive action on the tissues.

Economic and Geological History of Lignite Beds.

The lignites of the United States are largely confined to the Comanchean, Cretaceous and Eocene periods. The economic deposits lie almost wholly in the two last. This does not mean that specimens of great scientific importance will be found only between these horizons, for from the Triassic deposits of Texas I have collected interesting remains, and have studied wood from the Carboniferous which was in the lignitic state and so well preserved as to permit of easy identification. But these specimens from pre-Cretaceous strata occur in isolated fragments associated with clay or sand and can be of slight importance except to the palaeobotanist.

The earliest report of lignites in the western United States is probably that of Lewis and Clark in 1804, but outside sporadic references no detailed study was undertaken until 1869, when Dr. F. V. Hayden (1869) began his survey of the Western Territories. From 1869 to 1878, Drs. Hayden, Meek, Lesquereux, and others associated with the U. S. Geological Survey published extensively on the geology and palaeontology of this region which is almost uniformly underlain by immense beds of lignite. For many years there was a heated discussion concerning the geological age of these deposits; palaeobotanical and palaeozoölogical evidence was

contradictory. The testimony of the former pointed to the Eocene age of the strata (Heer even identified certain of the plant remains as Miocene), while the latter affirmed a Cretaceous age for them. The discussion has been reconciled by a decision favorable to both parties, for modern geologists agree that these debatable strata were laid down in a time of transition from Cretaceous to Eocene. Cretaceous reptiles still held sway, but the forests through which they wandered bore a Tertiary facies.

A list of the more important papers dealing with this vexed question, now happily settled, will be found in Hayden's Sixth Annual Report; and the reports themselves should be consulted for the extensive and detailed observations on stratigraphy, mineralogy, petrology, palaeontology, etc., of the region.

The great economic importance of the minerals contained in these rocks quickly absorbed the attention of geologists to the complete exclusion of more philosophical problems, and thenceforth the publications of the Geological Survey have been primarily economic.

The value of the lignite to dwellers in a region where fuel was scarce, was soon recognized, and development started on an extensive scale. Many new areas were prospected for coal and much money was expended in attempts to work coal-beds whose thin seams make profitable mining prohibitive. The Dakota Formation is a case in point. It is very doubtful if there are any paying coal seams in this formation. The same vain attempts have also been made to find paying lignite seams in the Triassic and Cretaceous strata of the eastern United States where small quantities of lignitized remains occur. Two areas only have maintained their supremacy as productive regions: the Great Interior Region—a vast expanse running from the 26th to the 55th parallel of north latitude, and from near the 103d to the 115th meridian; and the Pacific Coastal Area with mines confined almost wholly to California.

In the following analysis the lignites of the United States will be considered according to their geographical areal distribution, their chronological correlation, and their specific characteristics. All the data on Cretaceous correlations have been drawn from White (1891) who divides the United States into seven great areas where Cretaceous strata are exposed. These areas coincide fairly well with the lignite deposits and from five of them I have collected lignites. The Pacific Border has also yielded its quota but from rocks of a later age. White's divisions of the American Cretaceous are as follows:

1. Atlantic Border Region.
2. Gulf Border Region.
3. Texan Region.
4. North Mexican Region.
5. South Interior Region. } The Great Interior Region.
6. North Interior Region. }
7. Pacific Border Region.

The Atlantic Border Region and its Woody Remains.

From this region came the lignitic remains which formed the foundational studies of the work at Harvard.

Referring to White's tables, the Cretaceous strata offer the following type-section:

Tertiary		Eocene and later deposits.
	Marine Division	New Jersey Marl Beds New Jersey Clay Marls and their equivalents
	Non-marine Division	Raritan and Amboy Clays (hiatus in the South) Potomac Formation (hiatus)
Cretaceous and Comanchean		Older rocks: Triassic, Cambrian and Archean.

As the table shows, these Cretaceous (including Comanchean) deposits rest unconformably on the eroded earlier rocks. From the Potomac and Raritan beds have come the lignites. At the classic hunting-ground, Cliffwood, New Jersey, the Raritan and Amboy clays are worked for brick-making. They are also exposed in a sea-cliff not far from the town. In the spring of 1917, the Avery Brick Company struck a basal pavement of woody lignite in one of their clay-pits. It was a heterogeneous mass of crushed stems and branches, much of which showed marks of fire. From it we secured a quantity of structural material. This later proved to be mostly fragments of the wood *Brachyoxylon* Jeffrey, with some admixture of *Paracupressinoxylon* Holden and *Pityoxylon* Kraus. In the sea-cliffs other material of similar affinities was found, along with many pyritized cones of "*Sequoia*" (*Geinitzia*) *gracillima*. But there was no trace of *Sequoia* wood, and as Jeffrey has shown, these so-called sequoias are in reality araucarians with wood of the *Brachyphyllum* Brongniart type, *viz.*, *Brachyoxylon*. The woods will be considered in more detail later.

The Gulf Border Region.

In this area are included portions of the States of Georgia, Alabama, Mississippi, Louisiana, Tennessee, Kentucky and the whole of Florida. The following table not only shows the divisions of the strata, but correlates them with those of the Atlantic Coastal Plain.

	Atlantic Border Region	*Gulf Border Region*
Tertiary	Eocene and later beds	Eocene and later beds
	(hiatus)	(hiatus)
Cretaceous	New Jersey Marl Beds	Ripley Formation
	Clay Marls	Rotten Limestone
	Raritan and Amboy Clays	Tombigbee Sands
	(hiatus)	(hiatus)
Comanchean	Potomac Formation	Eutaw and Tuscaloosa Formations

The lignitic woods in the Gulf Formations are little known. Abnormally cold weather and snow made collecting almost impossible in the winter of 1917 when I reached this region, and what few fragments I found were from Tertiary deposits and of little interest. Comanchean and even Triassic lignites are known to occur in this area and later search should yield many specimens of interest.

The Texan Region.

This region has yielded some remarkable woods of widely diverse ages, for within the State of Texas there are structural lignites ranging in age from Triassic to Eocene.

The following table shows the sequence of deposits:

Tertiary (Eocene)	Fayette Division Yegua Division Timber Belt Division Basal Clays
Cretaceous, Upper or Black Prairie	Glauconitic Ponderosa Marls Austin Chalk Eagle Ford Shales Lower Cross Timber Sands (or Timber Creek)
Comanchean	Washita Fredericksburg Trinity or Bosque
Triassic	Dockum

The Triassic Lignite of Texas.—As has been stated, the Triassic strata of Texas contain lignitic woods. The first indication which came to hand of this fact was derived from a paper by Dr. Cummins (1890) in which he writes: "A few miles before reaching Dockum, situated in the western edge of Dickens County, [Dockum, by the way, is now non-existent except in name] I came upon a bed of conglomerate sandstone and red clay resting unconformably upon the clays and sandstones of the Upper Permian entirely unlike anything I have heretofore seen in Texas. This formation lies along the foot of the Staked Plains in a narrow belt. Because of its extensive occurrence in the vicinity of Dockum, I gave the formation the name of Dockum Beds. . . . In the conglomerate are many silicified trunks of trees."

Drake (1892) refers to these same beds again, and mentions the names of several geologists who had encountered a similar formation in equivalent stratigraphic position farther west. He then goes on to state: "A few miles west of the mouth of Blanco Cañon I found some pieces of trees that had been changed into lignite and imbedded in the sandstone of the conglomerate. The impression among people who have seen these trees was that they were probably the outliers of a bed of coal, but such is not the case. There is no probability that anything more than a few isolated pieces of lignite will be found there, and that, too, of very poor quality."

It was this almost parenthetic note which led me to the town of Spur in Dickens County, Texas, the nearest railway center to the region described by Dr. Cummins. Here I found a general vague knowledge among the residents of "coal" deposits in their neighborhood, but all assured me that it was not of any value. Our judgments of value, however, would scarcely coincide. The first definite information which came to hand was from Mr. C. B. Jones, manager of the Spur Farm Lands. The owners of these lands have made a detailed geological survey of their extensive holdings, and among other things, desirous of knowing what lay be-

neath, they sunk a boring to a depth of nearly one mile. This is the justly famous "deep boring at Spur" which actually traverses Tertiary, Triassic and Permian deposits and penetrates the Carboniferous strata for nearly four hundred feet. Mr. Jones placed in my hands certain unpublished data which Dr. W. O. Crosby assembled in 1916 and from them the following extract is taken.

We may note the position of the Dockum Beds in their relation to under- and overlying strata. This detail came from the deep boring.

5	Tertiary (Miocene)	200 feet
4	Triassic (Dockum)	300 "
3	Permian (Red Beds)	2000 "
2	Permian Dolomite	2850 "
1	Carboniferous (Cisco)	389 "

"The Dockum Beds," says Crosby, "consist of sandy clay and shale overlain by harder sandstone and conglomerate, the total thickness being from 200 to 300 feet.

"At many points in the coarse Triassic sandstone and conglomerate scattered masses of lignite, in the form of isolated fragments of trees, may be observed, but never anything like a regular or continuous bed of lignite and nothing at all approaching a workable deposit."

Through the kindness of Mr. Jones I was enabled to visit one of the localities mentioned by Crosby, and there obtained a quantity of structural material which as will be subsequently shown is very probably the wood of *Voltzia*. It lay in the banks of a small stream embedded in sandy clay, and associated to some extent with petrified and semi-petrified wood.

The Comanchean Lignites of Texas.—Referring once more to the Texas time-scale on page 49, it will be seen that the Triassic (with the exception of western Texas just considered) is typically overlain by Comanchean strata. The basal division of the Comanchean is the Trinity or Bosque, which in its turn consists of three beds: the Basement Sands beneath, the Glen Rose Beds overlying them, and the Paluxy Sands above. These are by no means constant but vary widely in their lithology, relative development and in their lignitic inclusions. In general it may be said that their best exposures lie in Wise, Parker, Hood, Erath and Bosque Counties; but for details of distribution, palaeontology, etc., reference should be made to the various publications of the Texas Geological Survey, especially to a paper by J. A. Taff (1892). The Trinity strata yielded structural lignites from three principal stations: (1) about one mile south of Cottondale (Glen Rose Formation) in a small cañon among the hills; also in the side of a low hill near the road which runs south from the same town; (2) near Weatherford, on Curtis Branch, and in a stream bank near the farm of Mr. Schleger about three miles from town; and (3) in the bed of Wolf Branch some three miles from the town of Bluffdale. The Cottondale deposit contained a stratum several inches thick of "leaf coal"—mere yellow cuticular flakes from crushed twigs. The Weatherford material from the second station is particularly valuable since much of it is in a charred condition.

"The whole of the Trinity formation, like the Potomac and Tuscaloosa formations, seems to have been littoral or at least not of open sea origin. This is indicated by lithological and also

by palaeontological characters so far as the latter are known." This inference is strongly corroborated by the included lignite, which in its scattered distribution and admixture with sand and clays, as well as its often lenticular and local beds, points to a condition of deposition in coastal basins at the debouchment of streams. On the other hand the overlying Fredericksburg and Washita deposits are just as clearly of marine origin: no wood is found — a negative character which can carry little weight — but the great calcareous deposits and marine fauna point clearly to the origin.

The Cretaceo-Eocene Lignites of Texas.—The lower Cross Timber Sands lie above the Comanchean. This is again a marine deposit but the fossils all differ, hence one must infer an unconformity though this is not evident. These marine strata, however, need not detain us, for not until the Eocene or late Cretaceous deposits are reached do lignites again appear. Hill definitely assigns these beds to the Eocene portion of the Laramie. White writes: "There seems to be little reason for doubt that the lignitic beds of eastern Texas, as well as those of the states of Mississippi and Louisiana which are usually regarded as of early Eocene age, are really equivalent to the upper part of the Laramie."

The woods which I collected from these strata are often angiospermous, and are sharply distinct from those of the Trinity which are gymnospermous, and indeed offer a facies strikingly similar to that of the Cretaceous lignites of the Atlantic Coast; namely, those of the Potomac and Raritan Formations.

The Texan Eocene lignites are confined to the three upper divisions: the Timber Belt, the Yegua, and the Fayette. No attempt has been made to differentiate these finer divisions in the following considerations on correlations. Here lie the great workable coal beds of Texas. The literature which deals with the economic aspect is voluminous and considers chemical analyses, coking and briqueting experiments, fuel values, distillation, etc. The woods themselves have apparently never been studied though everyone who has dealt with the lignites has remarked the prevalent woody structure and the miners vaguely surmise that this is poplar wood, or sycamore, etc. The deposit is enormous. It stretches entirely across the State from Red River to the Rio Grande, and its coal beds frequently show a thickness in certain localities of from eighteen to twenty-four feet. The belt is some 650 miles long, 200 miles wide and embraces 600,000 square miles of coal area.

Dumble gives the credit of the first published description to J. J. Riddell (1839) who noted the silicified trunks overlying the Brown Coal, "some of which show a diversified metamorphosis since some are partly lignitized or are converted into limonite." He further states that in the coal itself the "ligniform structure is almost always easily discernible." My collections from these Eocene deposits were made from mines at the following stations: Rockdale, Bastrop, Wooters, Como and Alba. This is substantially the list of mines given by Phillips and Worrell (1913). In their report will be found analyses, and discussions of the economic features of these coals.

White's next geographical division of the American Cretaceous, (no. 4), is the North Mexi-

can Region but at the time these investigations were in progress no American was entering Mexico in search of fossil woods.

The Great Interior Region.

South Interior Region.—This is a subdivision of the Great Interior Cretaceous area. It comprises Colorado and portions of Kansas, Nebraska, Wyoming, Utah, Arizona, New Mexico and northwestern Texas. It extends some 600 miles north and south and more than 800 miles east and west. Its strata practically belong to the Cretaceous period, rest unconformably on Jurassic deposits, and range in age from the Dakota to the Laramie.

North Interior Region.—This comprises nearly the whole of Montana and nearly or quite the whole of North and South Dakota, as well as parts of Nebraska, Wyoming, and Idaho; while in Canada the districts of Assiniboia, Alberta and the greater part of Saskatchewan, Athabasca and western Manitoba are included. It was said that the East Texas lignite deposit was enormous. The areal extent of the Great Interior deposit is staggering. When one considers that it has been traced (including northern Mexico) from the 26th to the 55th parallel of north latitude, a distance of nearly 2300 miles, and from the 103d to the 115th meridian, nearly 1200 miles, any theory to account for such prodigious deposits of wood becomes almost unthinkable. One can only postulate an extremely dense arboreal vegetation in a rainy climate, a land-locked sea, and vast stretches of time. This great Cretaceous deposit may be considered *en masse*. Its historical-economic aspect has already been noted above and we may now consider the classification of its strata and attempt a correlation with regions already discussed. Clark's (1891) correlation paper on the Eocene has been of great help here.

Hayden's Missouri section ran as follows, and beside it are given correlative divisions for deposits farther to the west.

Cretaceous-Eocene	Not recognized (or Fort Union)	7 Laramie
	5 Fox Hills group	6 Montana
	4 Fort Pierre group	
	3 Niobrara group	5 Belly River 4 Colorado
Cretaceous	2 Fort Benton group	
	1 Dakota group	3 Dakota
Comanchean		2 Kootanie (only in the north)
		1 Carboniferous or Devonian

Comanchean deposits are practically lacking in the South Interior region, but in the North Interior they are seemingly present as the Kootanie Formation. Furthermore in this same region the Belly River Formation is intercalated between the Colorado and the Montana Formations. In Alberta, Dawson states that the Kootanie rests unconformably upon Carboniferous and Devonian limestones. Some of its plants bear an Upper Jurassic facies. Newberry has recognized the lignite-bearing deposits of the Kootanie in the vicinity of the Great

Falls of the Missouri in Montana. Coal is also abundant in the Belly River Formation, while its flora and fauna are very similar to those of the Laramie.

1. *The Dakota Formation.*—The search for lignite in the Dakota Formation proved almost wholly unsuccessful. Hayden, Burchard (1904) and others have discussed the Dakotan lignites of Nebraska. In no locality, however, were there more than trifling and disappointing specimens available. At Hayden's (1869) type locality, Ponca, Nebraska, I collected a few pieces of badly pyritized wood and a few well-preserved angiosperm fragments. At Wilson, Kansas, there were formerly many mines but these are now wholly abandoned and fallen in, so that only carbon-bearing shales with rare charcoal fragments are to be seen. Old residents often assured me that they had seen lignites taken from these mines which showed the "grain of the wood," and doubtless a more thorough search would yield valuable specimens, particularly if the mines could be reopened. For unpublished data concerning these Dakotan lignites and for several specimens, I am particularly indebted to Dr. Barbour of the University of Nebraska, who also gave me several fragments of a Carboniferous lignite which is easily identified as a *Dadoxylon* species.

2. *The Laramie Formation.*—Not till we reach the Laramie do we again strike coal-bearing deposits in the Interior Basin, but here they are found in the greatest abundance. Owing to the historical confusion in which the strata were involved, the Laramie received many local names. Thus its several beds have been variously called Fort Union, Great Lignite, Judith River and Bitter Creek. An excellent discussion of the Laramie and its puzzles will be found in Clark's (1891) correlation paper on the Eocene. Lithologically the Laramie is rather uniform: its members are usually sandy or argillaceous and the whole formation contains coal and silicified wood. White considers it to represent deposits laid down in a great land-locked sea near the critical level and subject to frequent oscillation. Large islands were probably present.

The lignites of the Laramie are as evidently formed from transported woods as are those in Texas. Flattened branches are to be seen *in situ* with their extremities smoothed and rounded off by water action; some specimens of compact lignite show fragments of water-worn charcoal in almost every cleavage. Stumps of trees are not rare, but they are as often bottom-side up as in their natural position. At Cape Elizabeth, Washington, the beach is strewn with just such a tangle of stumps and woody débris, giving us some hint, perhaps, as to the conditions which prevailed in the great interior sea during Laramie times. The miners constantly speak of the lignite beds as made up of driftwood, and they are probably right in the inference. Leaf impressions are commonly found only in clays or sandstone above the coal, and their deposition marks the close of violent stream transportation and the inauguration of quieter conditions.

Beekly (1912) mentions an exposure in the bluff of the Missouri River, a few miles southeast of Culbertson, Montana. This lignite, however, is much weathered and of no botanical interest. Much of it—as is indeed a common condition in the northern area—has been burned, and the overlying clay is converted to red or pink porcelain-like clinker.

At a point farther up the stream, however, right at the place where a ferry plies over the river, there is a seam of lignite about five feet thick which was exposed in the spring of 1917 by one of the characteristic shifts of the Missouri. Here lie many large pieces of wood in the clays, both above and below the coal, while the foliated lignite itself contains charcoal.

Bauer (1914) has worked out in detail the deposit in the vicinity of Plentywood, Montana. The best specimens here are to be found at a mine about two miles north of the town. From the roof of the mine itself I obtained a large piece of wood from an upright stump and from the storage shed outside the mine many good fragments.

The Glendive Field (Hance, 1912) yielded only insignificant specimens. In the hills near the town there are lignitic clays and shales, but the chief mine of the area five miles east of Sidney, Montana, was full of water in September, 1917. At Hodges, however, in the same area there is a fine exposure of woody lignite (also rattlesnakes and scorpions!) in a "draw" just south of the town.

In North Dakota the Williston Lignite Field (Herald, 1913) gave the best specimens. At a mine three miles east of Williston one finds a very woody type of lignite with many charred and flattened branches. In the hills close at hand there is abundant silicified wood, gray to black on freshly broken surfaces, but weathering white and decomposing into asbestos-like fibrils.

At Sentinel Butte (Leonard and Smith, 1909) there is a remarkable deposit over twenty-five feet in thickness in the side of the Butte itself. It also is particularly woody.

The deposit at Medora in the same Bad Lands area is almost amorphous. This is somewhat surprising in view of the fact that Leonard and Smith (1909) give the inference that its woody structure is comparable to that at Sentinel Butte. From what one gathers from the miners, however, it would seem that these beds are subject to rather extreme horizontal variation. One continually hears statements to the effect that "last week we dug through a whole bed of logs."

The mines at Dickinson and Wilton (Smith, 1910) both yielded structural material but the Cannonball field (Lloyd, 1914) in the southern part of the State was wholly disappointing.

Colorado has long been famous for its coal deposits, but the sediments in this State have been profoundly disturbed and the attendant metamorphism has played havoc with the buried wood, in many cases converting it into a high grade of bituminous coal. It soon became evident that the only chance of finding structural material was to keep as far to the east of the mountains as possible. Hayden specifies Golden and Marshall as stations whence structural débris has been obtained. At Golden, in a clay bank close to the town, leaf impressions are to be found along with rare remains of branches, all extremely flattened and too much modified to permit of identification. Marshall again has several coal mines in operation but outside of "nigger-heads" (petrified trunks) little structural material is available. These coal beds are all near-bituminous.

It was in the banks of Monument Creek, between Colorado Springs and Breed, that the best Coloradan specimens came to light. One of Hayden's (1869) reports has the following

paragraph: "About five miles east of the base of the mountains and four miles northeast of Colorado City, Mr. Gehrung has a land claim where a coal bed crops out of the bank of a creek. Above the coal is about eight or ten feet of clay. . . . This clay is filled with fragments of vegetable matter, some seeds and plants." All trace of Mr. Gehrung and his claim has disappeared with the vicissitudes of time, but I am confident that the same formation is found along Monument Creek, for here are chocolate-colored clays filled with plant fragments most of which, very unfortunately, are mere carbonaceous films. Near Breed, however, lignitized trunks begin to appear and from one fine-grained sandstone I gathered pieces of a large palm stem which itself lay in a sheath of clay in the sandy matrix. At the mines near the terminus of the car line on North Tejon Street, woody material is not uncommon.

As to the coals in southeastern Colorado, *viz.*, in the Walsenburg district (Richardson, 1910), they are too nearly bituminous to yield structural remains. From western Colorado and southern Wyoming I can only report failure to find material of botanical value. Coal is abundant but either advanced to the bituminous condition or, exposed in natural outcrops to a long succession of insufferable summer suns, it has slacked into beds of black powder. It would be of interest to examine a fresh surface in the almost continuous exposures along the railroad cut and the Gunnison River from Grand Junction to Delta. The historic Rock Springs and Point of Rocks in Wyoming yielded only impressions.

The Pacific Coast Region (Tertiary).

Last of all there remain for consideration the lignites of the Pacific Coast found in the States of Washington and Oregon. As has already been said, California has Cretaceous beds containing lignite, but the beds in the States just mentioned are of either Eocene or later age. The existence of lignitic woods in the Olympic Peninsula was first brought to my attention by Dr. H. S. Conard, who made a trip into the region some years since. At my request he sent me the following memorandum from his notes taken at the time:

"Notes of walk from mouth of Queets River south to Grenville at mouth of Quiniault River:

"Beach narrow, bounded by high gravelly cliff, probably 50 feet or more. From 10 to 40 feet below top of this was an old forest bed with recent gravels below again and stumps in place. The wood of these was only slightly modified; gathered some near Raft River. The specimens mentioned are in the Dept. of Geology, University of Pennsylvania." Dr. Conard was also able to put me on the track of literature concerning these deposits.

The following table of the western Washington strata is adapted from one given by Weaver (1912). In the Tejon and Miocene strata lie the lignites.

Quaternary	
Pliocene	
Miocene	Quiniault Formation
Oligocene	Blakely horizon
	Porter horizon
	Lincoln horizon

Upper Eocene	Tejon Series	Arago Formation Olequa Formation Chehalis Formation
Lower Eocene	Wanting	

Basement complex of Palaeozoic and Mesozoic rocks.

Arnold and Hannibal have listed several "excellent plant localities" from the Tejon Series and it was among these that I selected a number for study. Four miles from Elma on Delazine Creek, fossil wood lies along the stream from whose bed it was derived. Some of it is almost jet-like in its hardness. Near Vader on Stillwater and Olequa Creeks, coal seams appear, containing logs and branches. This material is again very hard and splits easily with cubical cleavage. At Toledo on Salmon Creek, not far from Vader, fossil wood is abundant. The river gravels are strewn with flattened exfoliating trunks, while the clays of the banks contain charcoal and fine impressions. This wood is far less modified than that at Vader; some is even soft and yellowish inside.

The material which Dr. Conard reported from the sea-cliffs of the Quiniault Reservation, lies in Miocene gravels. I collected material both from Point Grenville and from the cliffs above Taholah north of the Quiniault River.

Arnold and Hannibal have also reported "abundant plant remains" Oregon, from Cape Blanco, which are embedded in volcanic ash. My interpretation of the adjective "abundant" scarcely coincides with theirs, however, since in a two days' search I found only a small quantity of wood fragments and a few cones of a Picea. This material is again Miocene in age.

So, as the result of a half-year's search, we now have a collection of American lignitic woods which range in age from the Triassic to the Tertiary Period; most of these are from Comanchean and Cretaceous strata. To the naked eye they can be seen to include both gymnospermous and angiospermous woods. They were collected from the States of New Jersey, Mississippi, Louisiana, Texas, Colorado, Nebraska, South Dakota, North Dakota, Montana, Washington and Oregon.

HISTOLOGY AND TAXONOMY OF LIGNITIC WOODS OF THE UNITED STATES.

In the opening portion of this paper the historical aspect of the subject of palaeobotany was considered and incidentally certain principles of diagnosis and classification were there discussed. It is unfortunately the case that certain details of wood anatomy much used by the older students are now known to fluctuate greatly between members of a single species or even within different parts of the same individual. Such, for instance, are detailed measurements of tracheid diameters, of wall thickness, of pit mouths, of ray dimensions, of the number of tracheids per annual ring, or of the relative amounts of spring and summer wood. The early investigators often rely all too strongly on such characters, and it thus becomes difficult to compare their species with those of more modern workers. From the mass of anatomical de-

tails, however, we have selected a certain set which the consensus of opinion regards as most stable. These are listed in the following table, and furthermore they are placed in a certain order which our diagnosis has followed throughout. The characters believed to be most important are italicized.

Table of Diagnostic Data to be Assembled from Wood Sections.

ANNUAL RINGS: *presence or absence of;* relative abundance of spring and summer wood; nature of transition from spring to summer wood.

RESIN CANALS: *normal or traumatic: one or both directions;* size, shape, etc.; *character of secretory cells;* presence or absence of tyloses.

WOOD RAYS: *uni- or multiseriate;* height in cells; shape, length, etc., of cells; *presence or absence of marginal tracheids;* of resin. Lateral pits as to *number per tracheid field, oöpores or oculipores,* shape and inclination of the mouth; *presence or absence of pits on other walls.*

WOOD PARENCHYMA: *terminal or diffuse;* abundance, distribution, contents.

TRACHEIDS: variation in size; *radial pitting as to seriation, crowding, bars of Sanio,* and pit mouths; *presence or absence of resin-filled tracheids;* of tyloses.

MEDULLA: size; *presence or absence of sclerites;* of resinous structures.

It is not always necessary to consider all these features and the list is to be looked upon as suggestive rather than accepted as a formal system.

A few definitions of words are necessary. We have adopted the term *wood ray* as urged by Jeffrey (1917), who very truly maintains that the term "medullary ray" is a misnomer. For if it means composed of medulla, then it is morphologically inaccurate; while if it means extending radially outward from the medulla, then a protostelic stem-cylinder with secondary growth, along with most roots, has no "medullary rays." The term *wood ray* represents simplicity and accuracy and should supplant complexity and inaccuracy.

Tracheid-field (first employed by Dr. Stopes), is used for Gothan's "Kreuzungsfeld" and Lignier's "aire mitoyenne." It applies to that portion of a tracheid which is covered laterally by a juxtaposed ray cell.

The need for two simple terms to distinguish the two types of lateral ray-pits has been felt and the terms *oöpore* and *oculipore* are coined. The word oöpore is the equivalent of Gothan's "Eipore" which has been somewhat extensively used by English and American authors. An oöpore is a lateral ray-pit of oval or more or less circular opening around which no border is to be seen. For the tracheidal pit has been modified *pari passu* with the broadening of the simple ray-pit till its border is wholly lost, and a clear unbordered area reaches from tracheid lumen to ray-cell cavity. Oculipore, on the other hand, is the term used for a lateral ray-pit whose opening seen against the bordered pit of the tracheid resembles the conventional figure of an eye. The oculipore grades into the oöpore, and according to Gothan, the term "Eipore" (our oöpore) may only be used when the border is entirely lacking.

Throughout the succeeding studies one single ideal has dominated—the ideal of phylogeny—and a careful search has been instituted for characters which, in the light of past studies in wood anatomy, have been shown to be of phylogenetic significance. This has taken definite precedence of any attempt to multiply genera or species, although it unfortunately becomes necessary

to make many new species, since the woods were largely from deposits never before studied as to their woody flora.

We have sought for stages in the evolution of the histological elements which are manifested in an advanced condition in modern conifers; or for reversionary characters due to traumatic stimuli; or for retentive and recapitulatory features.

In this ideal of the work, the "Principles of Comparative Anatomy" formulated by Jeffrey have been frankly applied. Derived by induction from a remarkably wide field of study, we believe their validity to be firmly established, and we have not hesitated to employ them deductively. If it be objected that these principles are not yet everywhere accepted as valid, one can but reply that the observed facts are recorded in some detail under each specimen considered, and they are thus open to independent judgment by those botanists who may not agree with our own inferences.

After three years of observation and study of the facts from which these principles were derived, and after witnessing striking confirmation of them in all the groups from pteridophytes to monocotyledons, we can affirm pragmatically: they work.

A Key to Coniferous Woods (including Cordaitales).

The following key to coniferous woods is based particularly on Gothan's system which includes the best points of the older systems and adds to them valuable diagnostic data derived from the rays. We agree with Dr. Stopes, however, in the advisability of using the generic name Podocarpoxylon in a wider sense than does Gothan. The particular change introduced has been in the inclusion of the traumatic resin canal as a feature of high diagnostic value. Further details of the system are considered later. In the general form of the classification we have used the system recently proposed by Conard (1919).

Cordaitales and Ancient Woods of Uncertain Affinity.

Woods of the Palaeozoic and early Mesozoic Periods with annual rings obscure or lacking, resin canals and wood parenchyma wholly (palingenetically) absent. Rays thin-walled and laterally pitted only with oculipores or oöpores. Tracheids beset with scattered or contiguous, uniseriate or multiseriate bordered pits. Bars of Sanio absent. . . . . *Dadoxylon* Endlicher (1847).
Woodworthia Jeffrey (1910a).
Voltzioxylon, gen. nov.
Xenoxylon Gothan (1910).
Callixylon Zallessky.

Coniferales.

Abieteae.

Annual rings usually distinct; resin canals either normal or traumatic or confined to conservative parts. Wood-ray cells usually pitted on all their walls. Wood parenchyma either wholly lacking or sparsely represented, and then commonly confined to the end of the annual ring. Tracheids of the adult wood with spaced, circular or oval bordered pits; these uniseriate, or when multiseriate, opposite one another; bars of Sanio present in the adult wood.

A. Normal resin canals well developed in both directions. . . . . (PININAE).

B. Secretory cells of the resin canals thin-walled. Marginal tracheids commonly present on the rays; lateral ray-pits in the form of large or small oöpores or oculipores; parenchyma only in connection with resin canals. ..... *Pityoxylon* Kraus (1870–72).

B′. Secretory cells of the resin canals thick-walled and lignified, the canals themselves more or less moniliform or fistular. Marginal tracheids present; ray-cells all strongly pitted and with small oöpores or oculipores on the lateral walls. Wood parenchyma usually present at the end of the annual ring. ..... *Piceoxylon* Gothan (1905).

A′. Resin canals only traumatic or confined to the conservative parts, usually vertical, only rarely in both directions. Rays strongly pitted on all their walls; lateral pits usually oculipores; marginal tracheids variable. Wood parenchyma if present terminal, rarely diffuse

(ABIETINAE)

Cedroxylon Kraus (1870–72).

Cupressaceae, Taxodiceae, and Taxaceae.

Annual rings usually distinct; resin canals neither normal nor traumatic (except in the last genus). Wood ray-cells pitted laterally with oculipores or oöpores, but commonly with few or no pits on horizontal and tangential walls. Wood parenchyma usually abundant and diffuse. Tracheidal pitting as for the Abieteae.

A. Resin canals neither normal nor traumatic.

B. Tertiary spirals absent.

C. Lateral ray-pits few to many; oculipores throughout the annual ring

Cupressinoxylon Göppert (1850).

C′. Lateral ray-pits one to few; large oöpores in the spring wood, in summer wood with or without borders. ..... *Podocarpoxylon* Gothan (1905).[1]

B′. Tertiary spirals well developed. ..... *Taxoxylon* Unger.

A′. Traumatic resin canals present in one or both directions; ray-pits sometimes widened to oöpores; otherwise as in *Cupressinoxylon*. ..... *Sequoioxylon*, new genus.

Araucariaceae.

Bordered pits of the adult wood more or less contiguous and flattened (except in young wood), uni-, bi-, or multiseriate, and when in more than one row typically alternate. Bars of Sanio and opposite pitting absent from the adult wood. Either resin canals (normal or traumatic), or parenchyma, or both present throughout.

Tribe I. Araucariopityeae.

Ray-cells heavily pitted on all the walls (abietean pitting). Normal or traumatic resin canals often present. Wood parenchyma usually absent; rarely terminal or diffuse.

Protopiceoxylon Gothan.
Araucariopitys Jeffrey.
Planoxylon Stopes.
Thylloxylon Gothan.
Metacupressinoxylon, gen. nov.

[1] The use of *Mesembryoxylon* Seward (1919) as a substitute for this genus has been considered. The term itself is preferable since it implies no relationship with *Podocarpus*. As the genus is diagnosed, however, it is too broad—including as it does *Sequoioxyla* (abietean pitting and resin canals), along with *Brachyoxylon* (cf. *M. hollickii* Stopes). We have for that reason preferred to use the genus *Podocarpoxylon* in the extended sense proposed by Dr. Stopes.

Tribe II. Brachyphylleae.

Ray-cells thin-walled and pitted only laterally; pits usually only small oculipores, sometimes oöpores; and few to many per tracheid-field. Traumatic (or normal?) resin canals present. Normal wood parenchyma absent..... *Brachyoxylon* Hollick and Jeffrey (1909).
Paracedroxylon Sinnott (1909).
Telephragmoxylon, Torrey (1921).
Anomaloxylon Gothan (1910).

Tribe III. Araucarieae.

Wood rays as in Brachyphylleae. Neither normal nor traumatic resin canals present (except in *Paracupressinoxylon potomacense* Sinnott and Bartlett). Diffuse wood parenchyma always present (confined to conservative regions in the living genera).
Paracupressinoxylon Holden (1913b).
Araucarioxylon Kraus (1870–72).

Discussion of the Key.

But few points in the preceding table need any discussion. Several attempts have been made in the past to distinguish between the genera *Dadoxylon* and *Araucarioxylon*, but it is the opinion of the European authority (Gothan) whose systematic work has had the greatest influence on coniferous xylopalaeontology in recent years, that the two cannot be separated, and he has adopted the name *Dadoxylon* Endlicher for all woods with alternating contiguous pitting and the typical araucarian ray. Seward (1919) does the same.

We have essayed, however, to effect a separation on a new basis. The *Dadoxyla*, under which we include not only cordaitean woods but others of unknown or problematical affinity, are wholly without resin canals or wood parenchyma. The absence of both these elements we believe to be palingenetic. On the other hand the Araucariaceae have been set apart because of the possession of either resin canals or wood parenchyma or of the two conjoined. As is well known, the living genera *Araucaria* and *Agathis* have neither of these structures in the stem wood, which at first sight would seem to destroy the distinction between *Dadoxylon* and *Araucarioxylon;* but a little consideration shows that the living genera all have abundant parenchyma in their root and in their cone axis. In other words its absence from the cauline region is held to be *a recent loss*. Furthermore, and substantiating this inference in the most remarkable manner, we have yet to find a true *Araucarioxylon* from the Cretaceous deposits (*viz.*, with characteristic pitting, rays, wound reactions and persistence of leaf-traces), which is not well supplied with wood parenchyma in its *stem* wood. This ready diagnostic feature of the genus may yet be found to be retained in the stem wood of all the fossil forms, for we are compelled to believe that the living genera represent a recent and final stage of regression.

In referring certain woods to an araucarian rather than to a pinacean affinity it must be admitted that the question of their position is one the answer to which depends upon the relative weight given to certain character combinations. We hold that anatomical and palaeontological evidence points to the Abieteae as the ancestors of the other coniferous groups. If this is so, then there are bound to be vague intermediate regions somewhere among late Palaeozoic or early Mesozoic conifers, in which the introduction of cupressean, or araucarian characters into a pine

complex, makes a sharp distinction between these groups almost impossible. Somewhere and sometime the araucarian pitting was substituted for the abietean, the bar of Sanio was lost, and resin canals passed from a state of epiphany to that of potentiality.

A notable example of such a transitional wood is *Araucariopitys* Jeffrey (1907); its rays are abietean, it possesses traumatic resin canals, but its tracheidal pitting and absence of bars of Sanio show that it is not of the nature of any true abietean wood with which we are familiar. In founding the genus *Araucariopitys* and subtribe Araucariopityoideae, Jeffrey has expressed its synthetic nature and has incidentally given us a group name to accommodate other similar woods which have since been found. We have only changed it from subtribe to tribe.

It became a question of extending the definition of the Abieteae or the Araucariaceae to embrace such annectant genera and the araucarian features were judged to be of strongest value. Thick-walled and heavily pitted rays are made by Gothan the feature upon which to base a final decision favorable to inclusion in the Abieteae, but it has been shown that the so-called abietean rays are present in conservative regions of living araucarians, and that they also occur as traumatic reversions. Hence one may well believe that their ancestors exhibited these features in their ordinary stem as well as in their root wood. It may be noted in passing that Gothan (1910) himself is impressed with the araucarian facies of the Polar woods which he described, for he says: "Es ist überhaupt gemein hinauffallend wie häufig man in der Hoftüpfel zahlreichen Hölzer der oberen Juraformation des Nördens, araucarioiden Charakteren begegnet." In regard to the positive characters upon which we base our reference to the Araucariaceae, namely the presence of contiguous flattened pits and the absence of bars of Sanio, the latter is of greatest importance. But since in petrified material, which is always inferior to good lignitic remains, this detail may be wholly undeterminable, one may be forced to depend upon the former only. The combination of the two seems, however, to be the only safe guide.

Among the *Cupressinoxyla* we have followed Gothan in our adoption of the genus *Podocarpoxylon,* but have used it in the broader sense advocated by Dr. Stopes. It must be admitted that it is not a clear-cut genus, for there is no sharp distinction between oculipores and oöpores. Furthermore, Miss Holden has described a *Dadoxylon* wood from India whose ray cells bear oöpores: which is also a feature of the taxodian genus *Sciadopitys.*

A word as to *Sequoioxylon* may be inserted. It is a clearly recognizable genus, the affinity of which with the living sequoias is close, although we do not maintain that all *Sequoioxyla* are woods of *Sequoia.* In cases of failure to find wounded areas, woods otherwise of sequoian habit must of necessity go into the genus *Cupressinoxylon.*

It is among the Araucariaceae that the greatest change has been made. The genera and species are becoming numerous and some form of classification was necessary. We have adopted Hollick and Jeffrey's (1909) three groups: Araucariopityoideae, Brachyphylloideae, and Araucarioideae raising them to the rank of tribes. No attempt has been made to formulate a generic key here. Diagnosis of several araucarian genera will be given later and references appended permit those interested to turn to the original generic descriptions. It will be evident that the

tribes are based on certain character combinations held to possess real phylogenetic significance. The Araucariopityeae, as the name suggests, include woods with a synthesis of abietean and araucarian characters: namely, abietean rays, normal or traumatic resin canals, and the usual palingenetic absence of wood parenchyma. Along with these characters, however, go araucarian pitting and total absence of bars of Sanio. Such woods are making the transition from the Abieteae to the Araucariaceae and are the most ancient of the araucarians. A few of them seem to have evolved wood parenchyma, though the genesis of this element is best illustrated by the next tribe.

The Brachyphylleae form a very natural assemblage; they have lost the ancient abietean ray, their resin canals are only recalled under traumatic stimuli and some of them (*cf. Telephragmoxylon, infra*) manifest incipient stages in the formation of wood parenchyma, along with the pitting and lack of bars of the more typical araucarians.

The Araucarieae seem to be continued regressions from the Brachyphylleae. Their resin canals are gone even beyond traumatic recall, but wood parenchyma has come to full expression. *Paracupressinoxylon* often seems to retain a type of pitting characteristic of the juvenile wood of *Brachyoxylon*. *Paracupressinoxylon potomacense* Sinnott and Bartlett (1916) is one of those annoying exceptions where Nature refuses to be relegated to formal categories. It is a wood transitional from Brachyphylleae to Araucarieae which has attained wood parenchyma but has not yet lost its traumatic resin canals. *Paracupressinoxylon cupressoides* and *Paracupressinoxylon trinitense* on the other hand seem to be without resin canals. More precise characters distinguishing the genus *Araucarioxylon* will be given under a later generic description. Kräusel (1918, 1920) has recently suggested a new family, Protopinaceae, to include among other forms, *Brachyoxylon*, *Protopiceoxylon*, and *Araucariopitys*. We cannot, of course, countenance the assumed phylogenetic position implied in this family name. Furthermore it does not seem wise to establish a new family for a group of obviously araucarian woods. Indeed it is with some doubt as to its desirability that we have raised the araucarians to family rank in accordance with Conard's classification.

Diagnoses and Descriptions of Twenty-two Lignitic Woods.

In the following diagnoses and descriptions the terms *annual rings*, *resin canals*, *wood rays*, *wood parenchyma*, *tracheids* and *medulla* are respectively abbreviated as: A.R., R.C., W.R., W.P., T., and M. From the diagnoses we have tried to keep out all reference to such facts as would characterize only the specimen in hand—such, for instance, as the possession of fungus or worm borings, or of slits in the tracheid walls, obliterated ray-markings, and other such artifacts. The order of treatment follows that of the key just discussed. A word is perhaps necessary regarding the system used in numbering these woods before they had been identified. Each specimen is referred to the geological horizon and State in which it was found, followed by two numbers. The first of these stands for a certain locality in the State, while the second is the number of the specimen itself. The first species considered, however, bears the reference number given it by its collector.

DADOXYLON Endlicher.

Pinites Witham, Observations on Fossil Vegetables, 1831.
Dadoxylon Endlicher, Synops. Conif., 1847.
Araucarioxylon Kraus, Sitzungb. Naturf. Gesellsch. zu Halle, 1882.
Cordaioxylon Felix, Untersuch. über d. inn. Bau westfal. Carbonpflanzen, 1886.
Cordaixylon Grand 'Eury.
Cordaites various authors.

Annual rings usually obscure or wholly lacking. Resin canals and wood parenchyma absent (palingenetic). Wood rays thin-walled, pitted laterally with few to very many small oculipores (very rarely oöpores). Tracheids abundantly beset with contiguous, uniseriate or multiseriate bordered pits; these, when in more than one row, alternating and hexagonal through mutual pressure. Bars of Sanio wholly absent.

Dadoxylon sp.

Carb. Neb. 15–7–12.

A.R. None.
R.C. None.
W.R. Uniseriate, few to 30 cells deep, lateral pits usually 1 or 2 oculipores per tracheid-field; other walls thin, unpitted.
W.P. None.
T. The radial walls beset with alternate or uniseriate contiguous pits with small oval mouths.

This specimen, which was given me by Dr. Barbour of the University of Nebraska, is badly pyritized but is of interest since it shows how a lignite from such a distant period as the Pennsylvanian may still be in a state of preservation sufficient to permit of diagnosis. This particular species of *Dadoxylon* is characterized by its small number of pits on the lateral walls of the rays,—nowhere have I seen more than two per tracheid-field. Moreover, they are relatively large and analogous to the oculipores of the Cupresseae. Such a small number of ray-pits, while not the rule, is not unknown among the *Dadoxyla:* thus, *Araucarites thamnensis* Göppert, *A. cupreus* Göppert, and *Dadoxylon vorgesiacum* Unger, are said to have one or two pits per tracheid-field, and also the few rows of bordered pits on the tracheids which characterize this specimen. In many characters too, it is similar to *Cordaites* (*Dadoxylon*) *recentum* Dawson from Prince Edward Island.

Dadoxylon sp. From Pennsylvanian Eurypterid Beds near Peru, Nebraska. Collected by Dr. E. H. Barbour.

VOLTZIOXYLON, gen. nov.

Synonomy as for *Dadoxylon*.

Annual rings indistinct or wanting. Both resin canals and wood parenchyma palingenetically absent. Wood rays usually uniseriate, thin-walled, and marked laterally with few to many small oculipores per tracheid-field. Tracheidal pits uni- or biseriate, usually spaced and circular; mouths tiny, oval or slit-like. No bars of Sanio. A characteristic Triassic wood.

Voltzioxylon dockumense, sp. nov.

Tr. Tex. 5.1.

A.R. Not visible.

R.C. None.

W.R. Uniseriate (?) few to 15 or more cells deep; cells in radial aspect resinous; lateral pits 2 to 9 oculipores per tracheid-field with slit-like openings; other walls delicate and unpitted.

W.P. None.

T. Beset with rows of spaced, circular pits with tiny slit-like to oval, crossed mouths; pits not rarely in two rows, then alternating but not flattened by pressure.

The discovery of this interesting Triassic wood has been noted above. The amount of detail exhibited by the radial sections is surprising since the specimen is badly crushed. Evidently our sections were taken from the longest diameter of a flattened branch, for in transverse and tangential sections the tracheid lumina are completely obliterated by crushing. The absence of annual rings, of wood parenchyma and of resin canals either normal or traumatic, with the possession of delicate-walled rays bearing numerous oculipores with slit-like openings, along with the abundance of alternating pitting, builds up a complex of features not found in any modern wood. Closest to it are the living araucarians, but these possess wood parenchyma in their conservative regions which leads to a conclusion, perfectly substantiated by their fossil representatives, that the lack of wood parenchyma in their stems is coenogenetic. In this Triassic wood, however, the lack of parenchyma is palingenetic, as is also the complete absence of resin canals.

In 1913, Miss Ruth Holden (1913a) described certain woods from Canada which she successfully linked up with the pith casts of *Voltzia coburgensis* Shauroth. There can be little doubt as far as histological comparison can prove identity that we are dealing with a wood of the same or an allied genus. The affinities of *Voltzia* have been much disputed. It has been placed among the Taxodieae and the Cupresseae, while Miss Holden suggests that it may be one of the earliest type intermediate between the Abieteae and the Araucariaceae. We incline, however, to the opinion that it represents rather a plant transitional to the Pinaceae and in view of its problematical nature have thought best to place it in a noncommittal position among the *Dadoxyla* and allied woods. If, as we believe, the absence of all resinous structures and of wood parenchyma are palingenetic features, then this reference is really the safest that can be made. In founding the new genus *Voltzioxylon* we are not thereby committed to the position that this Texan wood is the wood of *Voltzia*. Future studies may show that such is not the case and the way will then be open to remove it to its correct position.

An apposite word may be inserted concerning the genus *Woodworthia* Jeffrey (1910a) which was also derived from Triassic strata not far distant from those in which our own specimen was found. Its pitting is, however, more typically dadoxyloid, while the presence of persistent short shoots is a pinean feature we have not found in *Voltzioxylon*. Both this and our genus, however, lack wood parenchyma and resin canals.

Plate 8, fig. 1.—Transverse section. This figure is introduced to show the condition of much of the Triassic lignite. The tracheids are seen to be crushed flat, and their lumina blocked with resinous matter.

Fig. 2.—Radial section. In spite of the crushed condition the radial sections exhibit surprising detail. In our photograph both types of tracheidal pitting are evident, and in the cases of biseriation it should be noted that the pits retain their rounded form and are not hexagonal as in more typical *Dadoxyla*. On the left of the photograph portions of two rays are visible.

Voltzioxylon dockumense, gen. et sp. nov. Triassic Dockum Beds. Spur, Texas.

PITYOXYLON Kraus (in part).

Pinites Witham, Observations on Fossil Vegetables, 1831.
Pityoxylon Kraus, Schimper's Traité de Paléont. végétale, 1870.
Pinoxylon Gothan, Zur Anat. lebend. und fossil. gymnosp. Hölzer, Königl. Preuss. Geol. Landes. u. Bergakad., Berlin, 1905.

Resin canals normal in both directions, secretory epidermis thin-walled. Wood rays marked on the lateral tracheid-fields with oöpores, these sometimes very large; horizontal and terminal walls either pitted or smooth; marginal tracheids present on the rays and either smooth-walled (soft pines) or irregularly thickened (hard pines). True wood parenchyma wholly lacking. Tracheids beset with uni- to multiseriate bordered pits separated by bars of Sanio. When in two or more rows always opposite.

Pityoxylon sp.

Cr. Lar. N.D. 3.2.

A.R. Summer wood a thick zone some 30 cells wide.
R.C. In both directions; secretory cells thin-walled and sending tyloses into the canal cavity.
W.R. Uniseriate except when containing resin canals, one to ten cells high, resinous, marginal tracheids present. Ray cells thick-walled and strongly pitted on horizontal and terminal walls with one or two round oöpores per tracheid-field.
W.P. None.
T. With uniseriate pits, these circular with round mouths.

The specimen is not well preserved and partial decay has filled the walls with oblique cracks. It is hard to differentiate the marginal tracheids in radial section, but in tangential aspect the lateral walls of the uppermost and lowermost ray-cells possess bordered pits which are also dimly seen in radial aspect in face view. Whether the walls are smooth or dentate cannot be determined. A characteristic ray feature is the great variability in the inclusion of resin. Some cell rows are heavily filled with this brown secretion, while others are practically empty. Hence the rays in radial aspect are often zoned longitudinally with lighter and darker stripes.

A comparison with *P. columbianum* Penhallow (1907) is of some interest. That species has sparingly dentate marginal tracheids and large thin-walled resinous parenchyma cells around the resin canals. These sometimes form "large and irregular tracts upwards of 6–9 tracheids wide." Tyloses are not obvious. In the abundance of resinous parenchyma and lack of tyloses *P. columbianum* is not in accord with our species. As we have stated, it is impossible to make out whether the ray tracheids have dentate margins. Both woods, however, are derived from the great northern Laramie deposit.

Pityoxylon sp., from Cretaceous Laramie deposits at Sentinel Butte, North Dakota. Lignite mine.

Pityoxylon (Pinus) scituatensiforme (Bailey) n. comb.

Cr. Rar. N.J. 1.3.

A.R. Spring and summer wood not strongly differentiated. Limits of annual rings probably less clearly marked than in living pines.

R.C. Normal in both directions; the vertical canals surrounded by secretory cells with thick walls; tyloses abundant, and the whole secretory region inclosed in a sheath of highly resinous parenchyma which in cross-section appears in broad irregular patches. Horizontal canals in fusiform rays, smaller than the vertical.

W.R. Heavily resinous, 1 to 15 cells high, mostly uniseriate; cells usually large and laterally bulging; ray tracheids present, margins probably not dentate; lateral pits lenticular oculipores to large oöpores, about two per tracheid-field; horizontal walls thick and abundantly pitted; terminal walls thinner.

W.P. Lacking except for the patches associated with the resin canals; then thick-walled and pitted like the ray-cells.

T. Similar in size; pits large, circular, uniseriate, spaced; separated by bars of Sanio; the narrowed ends of the tracheids often moniliform due to the extreme size of the pits.

M. Cells thick-walled, heavily pitted and interspersed with nests of sclerites.

Four or five Cretaceous *Pityoxyla* with marginal tracheids are described in the literature. Two of these, *P. Sewardi* Stopes and *P. Woodwardi* Stopes, are from the Lower Greensand of England. *P. Benstedi* Stopes (1915) from the same level, is probably, as its author suggests, more closely related to *Larix* than to *Pinus*. It should at least be referred to the genus *Piceoxylon* Gothan. Another, *P*(*inuxylon*) *Paxii* Kräusel (1918) of Miocene age has recently been described.

The American Cretaceous species possessing marginal tracheids are *Pinus scituatensiforme* Bailey (1911), *Pinus protoscleropitys* Holden (1914), and *Pityoxylon Vateri* Platen (1907). Our species is undoubtedly the first and was in fact derived from the same locality. Bailey writes of the tylosed canals of his form, "surrounded by large masses of thick-walled and highly resinous parenchyma cells," its resinous rays, and its sclerotic pith; while his plates show figures which could be duplicated from our own slides, though our wood is in a better state of preservation.

In comparing the American and European species of Cretaceous *Pityoxyla*, one striking feature of similarity is to be noted, namely, the presence of masses of gummy parenchyma associated with the resin canals. For not only is this feature characteristic of the species possessing ray-tracheids, but it is seen in those in which these elements are absent, as for instance, *P. scituatense* Jeffrey and *P. foliosum* Holden. It must not be forgotten, however, that other and contemporary "pine woods" were without these curious parenchymatous tracts, so their value as a primitive characteristic must remain in doubt.

In referring this wood to *Pityoxylon* Kraus rather than to *Pinus* we do not thereby commit ourselves to the opinion that it belonged to the living genus. In *Prepinus* Jeffrey (1908) we already have another "pine" and other genera may yet be discovered.

Plate 8, fig. 3.—Transverse section. Introduced to show the curious resinous patches which surround the resin canals. Three canals are to be seen, around two of which the sheath of resinous parenchyma is particularly well developed.

Pityoxylon scituatensiforme (Bailey) n. comb. Cretaceous Raritan clays, Matteawan, New Jersey.

Pityoxylon *cf.* Vateri Platen.

Mio. Ore. 1.5.

A.R. Well marked; summer wood dense and transition from spring to summer wood rather abrupt.
R.C. In both directions; the vertical surrounded by a few rows of non-resinous parenchyma; mostly in the summer wood; horizontal canals in fusiform rays, not abundant and slightly smaller than the vertical canals.
W.R. Few to ten cells deep (twig wood), non-resinous; lateral field with one or two oöpores per tracheid-field; horizontal and terminal walls strongly pitted; marginal tracheids not visible.
W.P. None.
T. Pits uniseriate and pinean.

This specimen of pine wood is from a branch which is about twelve years old. The rate of growth, however, was very slow for the radial diameter is only about one centimeter. Hence we cannot be sure that the lack of marginal tracheids is a mature feature of the wood; and furthermore, the state of preservation does not permit us to deny their presence definitely. The non-resinous character of the rays and the resin-canal parenchyma is of some diagnostic value. A comparison with the amber-bearing *Pinus succinifera* (Göppert) Conwenz (1890) is of some interest. Both are from Tertiary strata and in that species the marginal tracheids are late in appearing. The colorless parenchyma around the resin canals is another point of similarity.

A relationship to, or perhaps identity with *P. Vateri* Platen (1907) from the Tertiary strata of California is suggested. This species has the same ray pitting as ours but dentate marginal tracheids were definitely seen.

Pityoxylon cf. *Vateri* Platen. Miocene volcanic ash deposits, Cape Blanco, Oregon.

PSEUDOTSUGA Carrière.

Pseudotsuga annulata (Platen) n. comb.

Mio. Ore. 1.6.

A.R. Very distinct; summer wood forming about one-half the yearly growth; spring wood very open and delicate. Twig wood dense with little variation in size of tracheids.
R.C. Normal in both directions; vertical canals often paired and usually confined to the summer wood; secretory cells thick-walled; horizontal canals much smaller and in elongate fusiform rays, sometimes two together.
W.R. Uniseriate (except for those which contain resin canals), two to twenty cells deep, slightly resinous; marginal tracheids present; lateral pits small, circular, two or three per tracheid-field, horizontal and terminal walls thick and strongly pitted.
W.P. Wholly terminal, not common.
T. With strong spiral thickenings in the spring tracheids, these not evident in the summer wood. Pits uniseriate with large circular mouths.

It would be pleasing to be able to identify this wood with *Pseudotsuga miocena* Penhallow (1907), but if one compares the two strictly it must be admitted that there is considerable difference. Thus *P. miocena* is said to have a thin zone of summer wood (three to ten rows) while in ours the summer wood occupies at least one-half the annual ring and is some thirty cells broad. Again, *P. miocena* has ray cells with "thin upper and lower walls devoid of pits." We are inclined to doubt this statement since such thin-walled and unpitted rays are not at all characteristic of the genus *Pseudotsuga*. The breadth of the summer zone is possibly a variable character.

From the living *P. mucronata* the wood differs in its less robust character, its far fewer resin canals and its more delicate rays which do not show the irregularity in tangential aspect of those of *P. mucronata*. From *P. macrocarpa* Mayr. it is to be separated because of the absence of resinous tracheids.

Under the name *Pityoxylon annulatum*, however, Platen (1907) has described an undoubted *Pseudotsuga* from California Tertiary deposits which seems to be identical with our own. He himself says of it: "Der Douglastanne findet sich noch heutigen Tages in Kalifornien. Das vorliegende Fossil durfte erweisen dass sie oder eine ihre nächsten Verwandten bereits in Pliocaen einen Bestandteil der Wälder dieses Landes bildete." We deplore the species name, since all *Pseudotsugae* are "annulatum," but the law of priority must permit it to stand. We feel justified, however, in removing it from the genus *Pityoxylon* to *Pseudotsuga*.

Plate 8, fig. 4.—Transverse section. In the lower part of the field is to be seen a zone of summer wood in which lie two small juxtaposed resin canals, while in the upper part a sheared zone of the much more delicate spring wood is visible.

Fig. 5.—Radial section. Tertiary spirals are here clearly evidenced and on one tracheid at the left hand of the photograph a row of round bordered pits is plainly visible.

Fig. 6.—Tangential section. Photographed to exhibit a horizontal resin canal running in an elongated fusiform ray. About five tracheids from the left-hand side, a cross-diaphragm may be noted; this is the end wall of a wood-parenchyma cell. In *Pseudotsuga*, wood parenchyma is confined to the end of the annual ring.

Pseudotsuga annulata (Platen) n. comb. From Miocene volcanic-ash deposits, Cape Blanco, Oregon.

PODOCARPOXYLON Gothan.

Cupressinoxylon Göppert, Monog. der fossil. Coniferen, 1850.

Podocarpoxylon (with *Phyllocladoxylon*) Gothan, Zur Anat. lebend. und foss. gymnosp. Hölzer, Königl. Preuss. Geol. Landes u. Bergakad., Berlin, 1905.

Resin canals absent. Wood rays with horizontal and terminal walls smooth; lateral walls marked (in the spring wood at least) with one to several oöpores. Bordered pits uniseriate or multiseriate, bars of Sanio present.

Podocarpoxylon texense, sp. nov.

Cr. Lar. Tex. 6.1.

A.R. Strongly marked because of the heavily resinous summer tracheids. Wood very coarse.

R.C. None; wounded areas produce only heterogeneous parenchyma and septate tracheids.

W.R. Uniseriate two to ten cells high and usually very resinous; lateral tracheid-field bearing one or two oculipores with lenticular openings, these may pass completely to oval oöpores on the spring tracheids; horizontal walls sparingly pitted.

W.P. Present and completely filled with resin, diffuse.

T. With peculiar pitting; the pits small to large, spaced, uniseriate, opposite and flattened; or alternate and flattened; sometimes of odd shapes; when contiguous an evident ridge lies between each pit and its neighbors thus enclosing it in a rim. More normal bars of Sanio also present. Tangential pits small and circular, usually scattered in more or less irregular rows.

This wood is extremely characteristic of the great Tertiary lignite deposits of eastern Texas. We have collected it from mines at Como where it seems to be particularly abundant, and again at Rockdale. As it comes from the mines it is of an ashy-brown color and cleaves easily into blocks. Its fuel value must be considerable because of its remarkably high resin content.

In nearly all its histological details this wood is so heterogeneous that it rather upsets all our formal "genera." Even its cross-section leads one to expect peculiarities, for the great tracheids with their rounded contours are commonly separated by what seem to be double walls but which in reality are the opposing faces of two bordered pits. The wood parenchyma is so resinous as scarcely to show its walls, while the rays in like manner are blocked, as are also the tracheids at the end of the annual ring.

The wood rays are diversified in their lateral pitting, for one discovers "sequoian" and "podocarpoid" pitting in the same low-power field with all degrees of inclination of the pore from upright to horizontal.

As to the pitting of the tracheids, there is such a diversity in size, shape and mutual relations of the pits as to make it difficult to think of anything similar. Sometimes they are scattered and small; again large and mutually compressed and alternate or opposite. When alternate and hexagonal through pressure they are usually separated by thickened rims which are probably of the nature of true bars of Sanio.

A careful search was instituted for resin canals but with wholly negative results. Several areas of wounded tissue were discovered, but the reaction had been toward tracheid septation and parenchymatization, and no evidence of schizogenous canals was found. We had suspected that the real affinity lay with *Sequoioxylon* but a careful consideration does not point that way.

Since the ray-pits are linear and upright in the summer wood and usually broadened to oöpores on the spring cells, we have referred this wood to the genus *Podocarpoxylon* Gothan, though a separation from *Cupressinoxylon* is somewhat questionable.

Plate 8, fig. 7.—Transverse section. Here the highly resinous nature of the wood is well brought out, for not only the rays but many of the tracheids are filled with opaque resin. This is particularly true of the summer tracheids, a line of which passes horizontally across the middle of the field. In the radial walls of several of the tracheids large pits are seen in section, appearing as two delicate walls bounding a lenticular area whence the middle lamella has disappeared.

Fig. 8.—Tangential section. This section is taken through the summer wood and the tangential bordered pits come out sharply along with the relatively low rays whose cells are often resin-filled. In the radial walls of the tracheids appear the bordered pits.

Plate 9, fig. 9.—Radial section. This shows a detail of the ray and attests the justice of our generic reference, for the oöpores are large and unmistakable.

Figs. 10 and 11: Show details of the tracheidal pitting of whose heterogeneous nature we have already spoken. Even the most skeptical cannot doubt that bars of Sanio are really present.

Podocarpoxylon texense, sp. nov. From Tertiary deposits, Rockdale, Texas; lignite mine.

Podocarpoxylon washingtonense, sp. nov.

Ter. Wash. 3.5. and 3.3.

A.R. Well developed, narrow; contrast between spring and summer wood marked.
R.C. None.
W.R. Uniseriate, few to twenty-five cells deep; lateral tracheid-field with about two small oöpores; other walls smooth.
W.P. Abundant, diffuse and heavily resinous.
T. Pits spaced and uniseriate.

(Probably the same as *Taxodioxylon sequoianum* (Merckl.) Gothan.)

Two specimens of this wood are at hand: one (much the better preserved) from a twig and the other from a large trunk. In the trunk wood the annual rings are narrow and strongly marked by the abrupt transitions from spring to summer wood. The cross-section appears thickly sown with wood-parenchyma cells. One slightly wounded area is included among the tangential sections, and here the parenchyma is particularly abundant, though it is not of the nature of wound-cap tissue. Resin canals have not been seen.

The rays are often twenty-five cells deep in the adult wood; in the twig they do not often run over ten cells in depth. The lateral ray-pits are in the form of one or two small circular oöpores per tracheid-field and even in the summer wood this shape is maintained (Gothan's phyllocladoid pitting). The bordered pits, almost destroyed by decay in the trunk wood, are uniseriate and round-mouthed.

These specimens came from the banks of Salmon Creek near Toledo, Washington. It seems to have been a common type of wood there in the Tertiary Period. The gravels of the stream are strewn with large exfoliating trunks, most of which show the same macroscopic features. A common character is the bright yellow color of the soft, inner, unoxidized portions of the trunk. In the clay along with the wood I found many fragments of charcoal and abundant impressions of the leaves of dicotyledons. Doubtless further search would reveal impressions of the leafy twigs of the very common conifer whose wood we have just described.

Kräusel (1918) has recently described a wood derived from eighteen different stations in German Brown Coal mines of Miocene age, which he identifies with *Taxodioxylon sequoianum* (Merckl.) Gothan. His diagnosis runs as follows: Wood of *Cupressinoxylon* structure, *viz.*, without abietean pitting. Wood parenchyma more or less abundant, particularly in wounded wood, and then with thick pitted walls. Resin canals traumatic, vertical and in tangential rows. Ray-pits rather large, and many on the tracheid-field. Pore of spring wood horizontal with almost obsolete borders, not circular but oval. The description fits our Washington wood very well except for the presence of traumatic resin canals in the German specimens. The

possession of these canals was not a character of the wood on which Gothan founded the species, and many of Kräusel's specimens are without them. Fig. 13, Plate 9, of this paper, should be compared with Kräusel's Fig. 2, Taf. 31, as should also Fig. 14, Plate 9, with Fig. 2, Taf. 33.

If the woods are identical, or very closely allied, as I suspect, then we have an interesting situation. Before reading Kräusel's article I had remarked upon the great quantities of this wood in the Tertiary deposits of the Olympic Peninsula. Kräusel considers *Taxodioxylon sequoianum* the "häufigsten vertretene Holztypus" of the German Tertiary Brown Coals. But what shall be done about its name? I have already explained that I cannot differentiate Gothan's finer divisions among *Cupressinoxyla* (in a large sense). I have adopted his *Podocarpoxylon* as a form-genus for woods with oöporous ray-cells; and *Sequoioxylon* for *Cupressinoxyla* with traumatic resin canals. This means that *Taxodioxylon sequoianum* according to our system must become *Sequoioxylon sequoianum*. It is probably the same wood as our *Podocarpoxylon washingtonense*. The transference to the genus *Sequoioxylon* does no violence to a wood of which Kräusel says: "Seine vollige Ubereinstimmung mit *Sequoia sempervirens* Endl. ist bereits von Gothan nachgewiesen worden."

Plate 9, fig. 12.—Transverse section. Portions of three annual rings are shown. The characteristic large, resinous, parenchyma cells scattered through the crushed wood are evident, as are also the strongly differentiated zones of spring and summer wood.

Fig. 13.—Tangential section. This figure is included to show a mass of thick-walled resinous parenchyma which is probably related to a slight traumatic disturbance. This is seen at the right of the figure, while at the left the more normal state of the parenchyma is visible.

Fig. 14.—Radial section; ray detail. Crossing the center of the field runs a ray five cells deep, and on almost every tracheid-field are seen one or two small circular to oval oöpores. Running vertically is a row of wood-parenchyma cells while on the tracheids are evidences of the bordered pits.

Podocarpoxylon washingtonense, sp. nov.? From Tertiary deposits, banks of Salmon Creek, Toledo, Washington.

Podocarpoxylon McGeei (Knowlton) Sinnott and Bartlett.

Cr. Rar. N. J. 1.6. and 1.4.

A.R. Defined by narrow zones of denser wood.

R.C. Not seen.

W.R. Slightly resinous, mostly uniseriate but not rarely with certain cells doubled. Rays rather widely varying in depth, from few to over thirty cells; narrow and straight; lateral pits one (two to three) oöpores in the summer wood, bordered, and with linear upright pores. Rarely lateral fusions are seen producing a lattice-like oöpore; other walls smooth.

W.P. Present; resinous; diffuse.

T. Narrow with uniseriate spaced or sometimes contiguous pits separated by bars of Sanio; pits rather uncommonly biseriate and opposite. Resinous diaphragms not uncommon.

The wood here described,—a well-preserved specimen, has somewhat the "feel" of an araucarian conifer. In its tracheid pitting it is brachyoxyloid, *viz.*, the pit arrangement varies from scattered and spaced to contiguous and flattened; in a few cases I have detected

alternate biseriate pits. Another araucarian feature of less importance is the not uncommon appearance of resinous diaphragms in the tracheids. Yet these araucarian characters cannot stand before the common condition of opposite pits and unmistakable bars of Sanio. The latter are exceptionally well developed on the large tracheids. All in all we seem to see in this wood an abietean type which is inclining in the araucarian direction and at the same time showing a ray character commonly held to be a podocarp feature. The reference to *P. McGeei* seems almost certain. Sinnott and Bartlett (1916) have diagnosed that wood as follows: "Annual rings poorly marked. Wood parenchyma present but not abundant. Tracheids usually very broad, their radial walls provided with large bordered pits in one or more rarely two rows, pits in the latter case opposite. So-called 'bars of Sanio' well developed. Pits from tracheid to ray generally one or two to the crossing field, large. Pore from rather small and obliquely vertical ('podocarpoid') to very large ('eiporig'). Rays thin-walled, pitless, frequently biseriate, and in many cases exceedingly tall, often attaining a height of sixty or more cells.

"Localities: Central High School and Meridian Hill Park, Washington, D. C.

"Horizon: Patuxent. (Lower Cretaceous.)"

A close comparison between the foregoing description and the diagnosis of our own specimen, shows that the only differences are such as might well be due to the more robust character of the Patuxent wood. Sinnott and Bartlett, however, speak of another specimen collected near Montella, D. C., that possesses narrower tracheids, etc., and they suggest a relationship to *Cupressinoxylon Wardi* Knowlton. Its resemblance to *P. McGeei*, however, is so close that they do not separate it. Now the differences are possibly only those which separate trunk and branch wood and into the latter category our own specimen probably falls. Thus *P. McGeei* has rays as deep as sixty cells; in our specimen they never run much above thirty. In the former they are largely biseriate, in the latter rarely so. Again, the former has very broad tracheids, while in our specimen they are narrow. In other respects, however, there is practical identity in detail, and preferring rather to err on the side of conservatism, we have referred it to the same species.

The discrepancy in the geological horizons is of more importance. Ours is from the Cretaceous Raritan clays; that of Sinnott and Bartlett from the Comanchean Potomac Formation. As is well known, however, there is no "lost interval" in the eastern United States between these periods, and a single Comanchean species of *Nageiopsis* (if *Nageiopsis* it be) may have persisted into the Cretaceous; but since a form "species" of wood does not necessarily mean specific identity in the Linnaean sense, it might well be that these two specimens from different horizons represent woods of two closely allied species.

The hypothesis of a podocarpoidean intermediation between the Abieteae and the Araucariaceae, which are so characteristic of Comanchean and Cretaceous deposits, gains added weight from the araucarian features of this wood, though it must not be forgotten that the "podocarpoid ray" has little systematic significance; for just such rays characterize the genus *Sciadopitys* as well as one undoubted *Dadoxylon*, not to mention many species of *Pinus*.

Under the name *Cupressinoxylon podocarpoides*, Reiss (1907) has described a Cretaceous or Cretaceo-Eocene wood from Japan with oöpores on the lateral walls of the rays. His opinion is that "da die Gattung *Podocarpus* heute eine typisch japanische Formengruppe darstellt, so war es gar nicht auffallend, wenn auch fossile Holz, entweder ihr selbst oder eine nahe verwandten angehört hatte, und auf diese Möglichkeit soll der gewählte Species-name des Holzes hinweisen." His wood seems to be closely related to the American species.

It is becoming apparent that in the Cretaceous period there was a strong similarity between the coniferous floras of eastern America and Japan. Thus *Brachyoxylon* (*Yezonia*) (Stopes and Fujii, 1910; Jeffrey, 1910) is a common wood in each country, and there is probable identity between our *Geinitzia Reichenbachi* (Geinitz) Hollick and Jeffrey and the Japanese *Cryptomeriopsis antiqua* Stopes and Fujii; while between *Podocarpoxylon McGeei* and "*Cupressinoxylon*" *podocarpoides* the resemblance is so evident as to declare a close relationship. Reiss' specimen should now be transferred to the genus *Podocarpoxylon* Gothan.

Plate 9, fig. 15.—Tangential section. Here the uniseriate rays are shown, one of them being twenty-five cells deep; and in addition one can see evidences of tangential pitting on the tracheids proving that this is summer wood.

Fig. 16.—Radial section. About one-half of the photograph is covered by a ray in which the oöporous character of the lateral pits is evidenced. The section, however, was taken through the summer wood and hence light borders sometimes appear. The tracheidal pits show up clearly, but the bars of Sanio are practically wanting in this particular field. In *Plate 10, fig. 17*, however, taken from another point on the same slide, the most skeptical cannot doubt the presence of these bars. The evident bars along with the prevalent opposite pitting wholly justify the reference to a non-araucarian affinity.

Plate 10, fig. 18.—This is introduced to illustrate a not uncommon condition of pitting in this wood. It is seen to approximate the araucarian condition.

Podocarpoxylon McGeei (Knowlton) Sinnott and Bartlett. Specimens collected from Cretaceous Raritan Clays, Matteawan, New Jersey.

Podocarpoxylon dakotense, sp. nov.

Cr. Lar. N. D. 3.1.

A.R. Present, summer wood a narrow zone of some three to six tracheids.
R.C. None.
W.R. Uniseriate, sparsely resinous, two to twelve cells deep, lateral pits usually one large, oval oblique oöpore per tracheid-field; in the summer wood oculipores possessed of slit-like openings.
W.P. None, but certain tracheids occluded with gum or resin.
T. Of medium diameter with thick walls and rounded lumen; summer tracheids of equivalent wall-thickness throughout, only varying in their size and tangential broadening; bordered pits uniseriate, usually spaced, but sometimes partly contiguous and flattened; mouths of pits extended as slits to their borders; no bars of Sanio seen.

The specimen is a cylindrical branch and this should not be forgotten in considering its tracheidal features. It is about 2.5 cm. in diameter, charred and in a fair state of preservation. Through its combination of dense wood, lack of parenchyma, ray-cells with large oöpores and somewhat brachyoxyloid pitting it is a distinctive specimen. Whether the resinous tracheids

are a normal feature or an artifact cannot be determined, but they are not obviously related to the rays as in the araucarians. The bordered pits are variable in size and distribution as well as in contiguity. They may be uniformly distributed over the whole length of a tracheid or show but three or four in the same region. In nearly all cases their mouths are extended as slits to the border of the pit, and thus it happens that when two are crossed the evident aperture of the pit appears squarish. The oöpores of the rays are correlated with these oblique mouths. The whole specimen is abundantly traversed with fungal hyphae whose tiny borings are thickly strewn over the tracheids. Bars of Sanio have probably been obliterated by decay.

There is no wounded area to prove the point, but we are inclined to believe that this twig may have belonged to one of the many "sequoias" which so characterize this epoch. The absence of wood parenchyma may be a recapitulatory feature. The fossil sequoias seem to be closer to the pines than do the modern species and the absence of parenchyma in young wood would not be surprising.

Podocarpoxylon dakotense, sp. nov. From Cretaceous Laramie strata, Sentinel Butte, North Dakota. Lignite mine.

SEQUOIOXYLON, GEN. NOV.

Cupressinoxylon Göppert (in part), Monogr. der fossil. Coniferen, 1850.

Annual rings strongly developed; contrast between spring and summer wood very marked. Resin canals wholly traumatic and in one or both directions. Wood rays with a few oculipores or oöpores on the lateral tracheid-field; other walls either smooth or sparingly pitted. Resinous wood parenchyma present, diffuse, sometimes confined to the summer wood. Tracheids with one to several rows of bordered pits separated by bars of Sanio, and when in more than one row, opposite.

Sequoioxylon montanense, sp. nov.

Cr. Lar. Mont. 1.1.

A.R. Very marked because of the abrupt transition between spring and summer wood and the extreme contrast between the two in size of cells; summer wood only two to ten cells thick.

R.C. Traumatic in both directions.

W.R. Uniseriate, delicate, few to twenty cells deep; the cells elongate vertically, and tangentially rather narrow; the lateral tracheid-field with from one to four oöpores with oval to circular openings.

W.P. Not abundant, and confined to summer wood.

T. Striking variation between tracheids of spring and summer wood, both as to size and wall-thickness. Bordered pits in from one to four rows, remarkably small; when in more than one row, strictly opposite; bars of Sanio well developed; pit mouths circular.

In considering this, the first species of an extremely interesting set of woods from the middle West, it is necessary to indicate not only the very evident sequoian features but also certain characters in which these ancient woods differed from those of more modern time. First of all it should be pointed out that they are, comparatively speaking, a modern group, for we have found no trace of such woods among strictly Cretaceous deposits. In their very coarse texture, with the surprising difference in wall-thickness between spring and summer tracheids, in

the diffuse wood parenchyma, and in their traumatic resin canals, these woods show striking similarity to that of the living Sequoias. Their ray-pitting is but slightly different and only such as might characterize various closely related species of a rich "sequoian" complex. The lateral ray-pits of all the living species of the genus show a tendency to approach the oöpore condition,—for their oval oculipores with somewhat horizontally directed axes very commonly lose almost the whole border. It is in their resin canals, however, that the ancient forms show their greatest difference. This difference has much theoretical significance. For whereas in the living *Sequoia washingtoniana* (Winsl.) Sudw. and *S. sempervirens* (Lamb.) Endl., only vertical canals return as a response to traumatic stimuli, in the four Tertiary species described here the same causes induce the formation of canals in both directions. The only logical explanation of this discrepancy is to admit that the ancient forms stand closer to their abietean ancestors than do the modern ones.

Kräusel (1918) has remarked concerning the Japanese *Sequoia* described as *S. hondoensis* by Miss Yasui (1917) that: "Wenn Yasui in der von ihm [*sic!*] beobachteten Harzgangbildung eine neue Bekräftigung von Jeffrey's Ansichten über die Stammesgeschichte der Koniferen sieht, ist er in Irrtum, da sie den bereits bekannten Tatsachen nichts hinzufügt." I feel that the same criticism cannot be made of the facts which I have set forth above. Along this same line it is of interest to note that the Miocene *Taxodioxylon sequoianum* has only vertical resin canals, which of course puts it on the level with the living Sequoias. This would be expected, since it is more recent than our Cretaceo-Eocene species.

Specific details of the wood under consideration may now be briefly discussed. The specimen is heavily charred and because of this it has been difficult to get cross-sections thin enough to permit one to distinguish accurately between tracheids and wood parenchyma. But it is clear that scattered through the summer zone are certain cells with larger lumen in which evidences of granular matter are not infrequent. In tangential aspect undoubted chains of parenchyma cells are often visible which seem to be wholly normal structures. They are filled with resin drops, a feature held by Penhallow (1907) to be diagnostic of *Sequoia* woods.

The wood rays are remarkably small in the tangential aspect; not rarely they broaden out in the middle part to receive one, or sometimes two small traumatic canals. The horizontal canals are not infrequently found in transverse section also, and in one case I was able to trace a certain canal through six annual rings. That they are really traumatic in nature cannot be doubted since they have been seen to join with the vertical canals which lie in tangential zones. The latter can be studied in both cross and longitudinal aspect and show themselves to be moniliform and tylosed. The ray-pitting is almost of the type denominated "podocarpoid" by Gothan. In the pitting of the spring tracheids there is witnessed another striking feature, for their radial walls have given plenty of room for display; triseriate pitting is common and even quadriseriation is not lacking. The pits are small and circular with round mouths, and are separated by bars of Sanio.

Any attempt to compare this wood with other and similar fossils which are described in the

literature is almost hopeless, since most of them have been included in the large and vague genus *Cupressinoxylon* and the most important character of all, the wound resin canal, has not commonly been observed.

Penhallow has differentiated the genus *Sequoia* and among the four species which he includes in his work on North American Gymnosperms (1907), three at least have traumatic resin canals. One of these, however, *S. Penhallowii* Jeffrey, is probably not a *Sequoia;* its reference to the genus was based on Penhallow's diagnosis. But Professor Jeffrey now inclines to the opinion that it is in all probability a primitive species of *Abies*. There remain then the two species: *S. Langsdorfii* (Brongniart) Heer, and *S. Burgessii* Penhallow. We believe that in one of our own species we have rediscovered *S. Burgessii*. *S. Langsdorfii*, on the other hand, must remain in some doubt, since the lateral ray-pits were not seen in it. But identity with the specimen here being considered, is ruled out on other grounds, for *S. Langsdorfii* has its "resin-cells rather numerous throughout the growth ring," which is not the case with our specimen.

Cupressinoxylon Holdenae Seward (1919) from the Eocene London Clay has shown only vertical resin canals.

Platen (1907) has described three woods from the western United States which undoubtedly fall into the genus *Sequoioxylon*. These are: (1) *Cupressinoxylon taxoidiodes* Conwentz from California Tertiary deposits, which possesses both vertical and horizontal (?) canals, very tall rays with from one to six pores per tracheid-field, and bordered pits in from one to four rows. Of this wood he says, "Die beiden recenten Sequoienspecies sind auf Grund ihrer Holzanatomie nicht zu unterscheiden." (2) *C. Pannonicum* (Unger) Felix is from Tertiary deposits of Nevada. It has vertical traumatic resin canals; two to five elliptic pores per tracheid-field, which are in one row on the inner ray-cells, and in two rows on the outer. The wood parenchyma is abundant and there are about two rows of bordered pits on the tracheids. And again he says, "Das Holz dürfte einer *Sequoia* oder *Taxodium* entstammen." (3) *C. distichum* Merkl. has not shown resin canals but it is probably a *Sequoioxylon* also; while last of all *Taxodium Credneri* Platen, from Miocene deposits has traumatic canals, very deep rays which are sometimes forked ("gegabelte"), and clearly manifested transitions from septate tracheids to wood parenchyma. Platen does not speak of the occurrence of oöpores on the rays of these species though Gothan's use of oöpores as a diagnostic detail was published two years before his thesis, hence we may infer that they were not a striking feature of the woods. We are not able to identify any of our species with these of Platen, which is not surprising, since his specimens come from later horizons.

It is of interest to see that xylopalaeontological study confirms the evidence supplied by impressions of the existence in America in the Tertiary period of a widely dispersed group of conifers which were of sequoian affinity. Such woods have now been found in California, Nevada, Montana, North Dakota, Colorado, Yellowstone Park and Saskatchewan.

Plate 10, fig. 19.—Transverse section. Here is shown the extreme contrast between spring and summer wood. The spring zone is so exiguous that it has been unable to withstand the pressure to

which it was subjected and the consequent shear is very evident. The wood parenchyma is not well seen in this figure.

Fig. 20.—Tangential section. This was taken through the summer wood since it is impossible to get a strictly tangential section through the spring wood because of the distortion. The uniseriate rays are evident, and a little to the left of center is seen a dark resinous plate held in a cavity which marks the position of a row of parenchyma cells.

Fig. 21.—Transverse section. In this figure we see the traumatic resin canals. The spring wood is far more collapsed than in Fig. 19; but since the resin canals are in the summer zone they are not profoundly disturbed. A little to the right of center a horizontal canal is seen crossing the vertical row. There can be no doubt as to the traumatic nature of these canals. They are filled with yellow vesicles of resin and when cut longitudinally manifest the moniliform appearance common to such traumatic structures.

Fig. 22.—Radial section. The distortion makes it difficult to get any clear-cut radial view, but this figure brings out the heavily pitted tracheids. On the most prominent one of them, near the center, lie three rows of small pits. In the upper left-hand corner a bit of a ray is visible with the lateral tracheid-fields marked with oval oöpores.

Fig. 23.—To show the bordered pitting more sharply, this view, similar to the last, is introduced.

Sequoioxylon montanense, sp. nov. Charred wood from Cretaceous Laramie deposits, bank of the Missouri River, Culbertson, Montana.

Sequoioxylon dakotense, sp. nov.

Cr. Lar. N. D. 5.3. and 5.1.

A.R. Very marked through the contrast of spring and summer wood. The latter dense and from two to eight cells in thickness, the former thicker and made up of very large thin-walled cells, thus occupying a zone ten times as broad as that of the summer wood.

R.C. Traumatic in both directions; the vertical in tangential rows and conspicuous; the horizontal in fusiform rays, small and rare.

W.P. Present throughout the ring but not abundant.

W.R. Usually uniseriate, few to twelve or more cells deep, averaging about six or eight; narrow, resinous; lateral pits oval, of medium size, oöpores, or sometimes with slight borders; two or more per tracheid-field, the long axes horizontal or slightly oblique; other walls smooth.

T. Spring tracheids very large and with from one- to four-seriate large, round pits, when in more than one row the pits strictly opposite; bars of Sanio strongly developed.

This wood is striking in all its microscopic features. The strong contrast between spring and summer wood, the numerous vertical traumatic canals and the abundant large pits on the tracheids are all sequoian features. The chief character which separates it from the last species is the far greater size of the bordered pits. This cannot depend on the greater age of the wood for both are from the trunk wood of large trees and the tracheids do not vary much in diameter. The pits of *S. montanense*, however, have a peculiar dwarfed appearance. At one point in the sections, I have detected a zone of septate tracheids in the summer wood. It will be recalled that Platen noted the same in the fossil wood which he named *Taxodium Credneri*. It is of interest, however, as a manifestation of the general principle that traumatic stimuli lead to reversion. For we hold that this condition of tracheid septation antedated the condition of true parenchymatization, and later on we shall show the notable confirmation of

this theory which has come to light. The same reasons which led us to set up *S. montanense* as a new species apply in full to this specimen also.

Plate 10, fig. 24.—Transverse section. Across the field runs a row of vertical traumatic resin canals.

Plate 11, fig. 25.—Tangential section. In this figure a vertical canal with its secretory parenchyma is shown in longitudinal section. Its moniliform appearance is eminently characteristic.

Fig. 26.—Radial section. The extreme brittleness of the carbonized tracheid walls is evidenced by the shattered appearance of this section. On the left, portions of several tracheids show well the bordered pits.

Fig. 27.—Radial detail of tracheid. This figure is introduced to show not only the typical opposite pitting but also the unmistakable bars of Sanio.

Fig. 28.—Radial detail of ray. That the lateral ray-pits are of the type held by Penhallow to be diagnostic of the genus *Sequoia* is evident. It should be noted that they closely approach the oöpore condition and that their axes are decidedly oblique. In the central row of ray-cells a tangential wall is visible; it is somewhat thinner than the horizontal ones.

Sequoioxylon dakotense, sp. nov. Charred wood from Cretaceous Laramie deposits; Wilton, North Dakota: lignite mine.

Sequoioxylon laramense, sp. nov.

Cr. Lar. Mont. 2.4.

A.R. Very strongly marked.

R.C. Traumatic in both directions.

T.R. Uniseriate, not often more than ten cells deep; cells oval to circular; lateral pits one or two (three), round oöpores.

W.P. Abundant in the summer wood, filled with resin drops.

T. Pitting uni- or biseriate, when in two rows, opposite; pit mouths round; bars of Sanio present; tangential pitting abundant at end of annual ring.

This wood is in some respects similar to *S. montanense*, for it has traumatic resin canals in both directions, wood parenchyma in the summer wood, and oöpores on the ray-cells. The rays differ, however, in the larger size of their cells and the wood parenchyma is far more abundant. This last character also differentiates it from *S. dakotense*. Again this species has not the peculiar small pits which characterize the tracheids of *S. montanense*. The traumatic resin canals are very common; scarcely a block of wood can be sectioned but shows long tangential bands of these extremely well-developed structures. They are surrounded by strongly pitted parenchyma and are often somewhat tylosed. The horizontal canals, on the contrary, are rare. They are best seen in the tangential aspect of the summer wood, for the spring wood is usually crushed and sheared. They are lenticular in outline and not abnormally large. The wood rays, as stated in the diagnosis, are of the ordinary coniferous type and bear from one to three oval to circular oöpores on the lateral field. Wood parenchyma is plentiful in the summer wood. In transverse section its cells are distinguishable among the heavy charred summer tracheids by their larger lumen and drops of resinous secretion. In tangential aspect the same features, along with their cross-walls and simple pits, show clearly. Here, then, is another Montanan *Sequoioxylon* which was found at a station about thirty miles north of the one whence came *S. montanense*, but in deposits of the same age. Its evident

resemblances have been pointed out and the two species were probably closely related. Both belonged to a group not so far removed from the Abieteae as are the living Sequoias.

Plate 11, fig. 29.—Transverse section. Here are exhibited not only the great contrast between spring and summer wood, so characteristic of all these sequoian species, but also a row of vertical and tylosed resin canals running through the middle of the field and crossed at right angles by a horizontal canal which is best seen moving through the uppermost zone of summer wood where it broadens out.

Fig. 30.—Transverse section. This figure is included in order that the wood parenchyma may be shown. Scattered through the dense zone, whose uncrushed condition is evidently dependent on the very great thickness of its tracheid-walls, one can see cells with larger lumen than the majority which surround them; these are wood-parenchyma cells. In the lower right-hand part of the photograph three of these may be seen to have resinous contents.

Fig. 31.—Tangential section. This specimen is so heavily charred that it is difficult to get a section that will show details. However, in the center of the field lies a fusiform ray with a horizontal resin canal containing vesicular resin. Above and to the left of this the appearance of tangential pits on the tracheids proves that this is summer wood. To the right of the resin canal several parenchyma cells with resin drops are seen.

Sequoioxylon laramense, sp. nov. From Cretaceous Laramie deposits, Plentywood, Montana; lignite mine.

Sequoioxylon (Sequoia) Burgessii (Penhallow) n. comb.

Cr. Lar. Col. 2.5.

A.R. Well developed, zone of summer wood thin.

R.C. Horizontal canals traumatic, very large, lenticular and blocked with tyloses. Vertical traumatic canals not seen. The lenticular areas often appear to contain two canals.

W.R. Uniseriate, few to fifteen cells deep, not particularly resinous, lateral pits from one to three oval to circular oöpores per tracheid-field; other walls smooth.

W.P. Present and confined to the summer wood, slightly resinous.

T. Pits uniseriate, or opposite biseriate or triseriate and separated by bars of Sanio; mouths large and oval.

The most striking feature of this wood is the presence of the extremely large resin canals bounded by an epithelial lining one or two cells thick. Into the lumen are thrust large bladdery tyloses. These great resin canals are also often seen in cross-section and it is sometimes possible to follow them through many annual rings since their great size offsets the disjunctions which a plane section would cause in a small and sinuous canal. Vertical traumatic canals have not yet been seen, but in one section a tangential band of resinous parenchyma is visible which may well contain resin canals whose lumina have been obliterated by crushing. The possession of such extremely large resin canals is not a sporadic feature. They have been noted in several European woods. For instance, they occur in *Protopiceoxylon* Gothan (1910) which is said to have normal resin canals in addition. Gothan's text-figure of one of these traumatic canals closely resembles the canals of our own specimen even to its double nature. The great "Spindelmarkstrahlen" of *Anomaloxylon* may belong to the same category. An identity of our species with it is, however, completely excluded on all the other characters, for it is very doubtful if woods with "Hoftüpfel meist einreihig, oft gedrängt und alternierend, unter- und oberwarts abgeplattet (araucarioid)," can be relegated to the Abieteae.

Pityoxylon silesiacum Göppert from Tertiary deposits of Japan is another wood that has these enormous resin canals. Neither are they unknown in living genera, for we have been shown sections of an abnormal piece of *Picea mariana* (Mill.) BSP. which are spotted with extraordinarily large canals of this character.

Under the name *Sequoia Burgessii*, Penhallow has described a fossil from the Eocene of the Porcupine Creek and Great Valley groups which is either identical with or very closely related to our specimen. Vertical resin canals seem to be wholly wanting, but in tangential aspect there are seen large resin passages containing tyloses. In other features also the wood agrees closely with our own and we feel justified in referring the latter to the same species.

Plate 11, fig. 32.—Transverse section. Running obliquely through the sheared zone of wood is seen a large tylosed resin canal.

Plate 12, fig. 33.—Tangential section. In this photograph a canal similar to the last is seen in tangential aspect. In the large lenticular ray lie two resin cavities surrounded by a common mass of secretory parenchyma.

Fig. 34.—This is similar to the last but a little to the right of center are seen several rows of wood parenchyma.

Fig. 35.—Radial detail of ray. Even as in *Sequoioxylon dakotense* the sequoian ray-pits with their approximation to the podocarpoid condition are evidenced.

Fig. 36.—Radial detail of tracheid. The bordered pitting has a resemblance to that of *Sequoioxylon montanense*. The traumatic canals, however, fully justify a separation from that species.

Sequoioxylon Burgessii Penhallow. From Cretaceous Laramie deposits, Colorado Springs, Colorado; lignite mine.

BRACHYOXYLON Hollick and Jeffrey.

Araucarioxylon Kraus, in part.
Brachyoxylon Hollick and Jeffrey, Mem. N. Y. Bot. Garden, vol. 3, p. 54, 1909.

Annual rings usually visible; traumatic resin canals present. Wood rays thin-walled with few to many small oculipores on the lateral tracheid-field. Wood parenchyma absent. Tracheids beset with scattered or contiguous pits, when biseriate always alternate. Bars of Sanio absent. Pith large and interspersed with stone cells.

Brachyoxylon woodworthianum, sp. nov.

Cr. Rar. Mass.

A.R. Obscure.
R.C. Traumatic in the vertical direction.
W.R. In twig wood, uniseriate, from one to three cells high, resinous; in older wood uniseriate or biseriate, two to twenty cells high, somewhat resinous; traumatic rays thick-walled with abietean pitting; lateral tracheid-field with few to many oculipores with elongate and slit-like openings.
W.P. None.
T. Pits in the twig wood scattered and uniseriate; in the older wood scattered or contiguous, uniseriate or more rarely alternate and biseriate. Bars of Sanio not present. Resin-filled tracheids confined to twig wood and usually definitely related to the rays.
M. With scattered stone cells.

This interesting wood was found on the island of Martha's Vineyard by Professor J. B.

Woodworth and was turned over to me for study. The specimen consisted of a large piece of lignitized trunk wood in which there was very fortunately embedded a small twig so well preserved that it could be studied in detail and its structure compared with that of the adult stem wood. To the naked eye there were visible on the large fragment about one hundred rings; these can also be seen, but not so well, under the microscope. The wood is somewhat crushed but the histological details are well preserved. The presence of traumatic resin canals and the absence of parenchyma show that it belongs to the subtribe Brachyphylleae.

The traumatic rays deserve some consideration, since, in addition to the significant possession of abietean pitting, their cells often contain nuclei. It is in the comparison of twig and trunk wood, however, that the greatest interest lies. The differences between these two are profound enough to relegate the portions to two different species, were their anatomical connection unknown. The twig possesses low, non-resinous rays. In cross-section these are often seen to be bordered by resin-filled tracheids, although the latter sometimes spread out in fan-shaped masses. But perhaps the most significant feature is the abietean character of the tracheidal pitting, *viz.*, abietean in the fact that the pits are scattered and rarely contiguous. They lack, however, any trace of intervening bars of Sanio. The pith contains sclerites and the primary wood is of the ordinary coniferous type. The earlier tracheids possess a much closer type of pitting than do those which soon follow, and an even more significant feature is sometimes seen, for certain of the earliest-formed tracheids are beset with true *Dadoxylon* pitting. The trunk wood has highly resinous rays, no resin-filled tracheids, and almost exclusive araucarian pitting, which even takes on alternating contiguity.

The lucky discovery of twig and trunk wood of a single *Brachyoxylon* species permits us then to realize that scattered pitting is not necessarily an abietean feature. If a Cretaceous wood lacks bars of Sanio, and if at the same time the rays are of the araucarian type, it must be referred to the Araucariaceae. This warning is needed since some doubt has been expressed concerning the correctness of former diagnoses of certain woods from the Raritan deposits. In many cases the remains were small but highly important axes, such as those of cones and leafy twigs, and the pitting was often found to be similar to that of the twig wood of the *Brachyoxylon*, sp. just described. Hence one might be easily led to assume the abietean or cupressean nature of the fragments, since he might not realize the value of ray, or pith, or traumatic characters upon which the conclusion as to the correct affinity of the specimen was founded.

Plate 12, fig. 37.—Transverse section of adult wood. The section is not highly magnified but the absence of marked annual rings is to be noted. The rays have largely lost their walls, but their course is indicated by the resinous inclusions.

Fig. 38.—The wood of this section came from the same block as the last but it has suffered far more from shear. The significant feature is the row of resin canals running across the field; they manifest the usual appearance of such traumatic reversions.

Fig. 39.—Tangential section. On one side of this figure three great traumatic rays appear while on the other side rays of the normal character are profusely scattered. The traumatic cells have the thick and pitted walls held to be characteristic of the Abieteae.

Fig. 40.—Radial section. Here is shown a feature to which attention was called above, namely, the presence of nuclei in the traumatic ray-cells. Preserved in the resinous matrix, they have retained a startlingly life-like appearance. The heavily pitted rays are seen to better advantage also and the uniseriate tracheidal pitting is in evidence.

Plate 13, fig. 41.—Radial section. Tracheidal detail, to show the more typical "araucarian pitting" of the wood.

Fig. 42.—Radial section of twig. This photograph was taken at the junction of medulla and primary wood. At the right is the dark resinous mass of the pith; on its left-hand border lie two small tracheids with spiral thickenings, then follow two tracheids with reticulate markings, and next to these the most significant element of all,—a tracheid beset with alternating, mutually flattened pits. It is a striking case of the retention of true *Dadoxylon* pitting.

Fig. 43.—That the type of pitting just shown is not the normal type of the twig tracheids is proved by this figure taken at some distance from the center, for here there is no evidence of crowding, but instead the scattering of pits commonly held to be characteristic of the Abieteae. The ray-pits are also clearly visible on the low ray, but their spindle-like form is due to the partial decay which has also produced striae and cracks in the walls of the tracheids.

Brachyoxylon woodworthianum, sp. nov. Lignite from the island of Martha's Vineyard, Massachusetts, Cretaceous, Raritan deposits.

Brachyoxylon comanchense, sp. nov.

Co. Tex. 1. 41., 1.11.

A.R. Delimited by a row of tracheids two or three cells wide; annual rings often variable in density.
R.C. Traumatic and vertical only.
W.R. Uniseriate, from one to six cells deep, cells almost circular, slightly resinous; lateral pits up to twelve per cross-field, tiny, circular to oval in outline.
W.P. None.
T. Very variable in size in different zones, radial pits usually contiguous and flattened, rarely biseriate; on large tracheids often horizontally elongate and with large oval mouths.
M. Containing sclerites.

Two specimens of this wood are at hand: one of these, no. 1.41, is from a young branch, while no. 1.11 is from trunk wood. In the first specimen two lateral twigs are making their exit, thus permitting a view of the sclerotic pith-cells. Its tracheids are also comparatively narrow and its pits small. In the other the very large tracheids are covered with great oval pits. The difference in size of the tracheids of various annual rings is often considerable and suggests rather extreme climatic variation. The traumatic resin canals lie in a tangential zone which on one side can be seen gradually to fade out into a strip of heterogeneous and partially parenchymatous tissue. Certain cells in this area are crossed with walls bearing bordered pits, and thus seem to be true septate tracheids similar in nature to those which occur as a normal feature in the genus *Telephragmoxylon* at the end of the annual ring. Such a septation of tracheids possesses little significance, however, when confined to wounded regions, since it is found in almost all genera of woods. The lumen of the traumatic canals is usually partially occluded by resinous and simply pitted parenchymatous tyloses. In radial sections their moniliform character is seen along with the modified tracheidal tissue which surrounds

them. The ray-cells are quite typically araucarian, but their pit openings are far less slit-like than in many true *Araucarioxyla* or certain other *Brachyoxylon* species.

Specimen no. 4.13 is doubtfully included with the above; its bordered pits have slit-like mouths and the oculipore openings, too, are more elongate than is the case in the other two specimens.

Plate 13, fig. 44.—Here are shown the well-developed resin canals invaded by tyloses, and also the annual rings which are more strongly marked than in *Brachyoxylon woodworthianum* though even here the summer wood is very slightly differentiated.

Fig. 45.—A portion of a resin canal in radial aspect; it lies in the center of the field and is seen to be moniliform and tylosed. On various tracheids the contiguous uniseriate pits are visible.

Fig. 46.—Radial section, ray detail. Five tiers of ray-cells appear in this photograph, and on the lateral tracheid-field are seen the numerous tiny circular to oval openings of the oculipores.

Brachyoxylon comanchense, sp. nov. From Comanchean deposits, Cottondale, Texas; bank of stream.

Brachyoxylon raritanense, sp. nov.

Cr. Rar. N. J. 2.7.

A.R. Poorly marked but sometimes delimited by a slight narrowing of tracheids.

R.C. Not seen.

W.R. Few to fifteen cells deep, not highly resinous, lateral walls with from one to nine oculipores per tracheid-field, these small with slightly elongate oval mouths, not usually slit-like.

W.P. None.

T. Often resin-filled; bordered pits typically brachyoxyloid, *i.e.*, contiguous and flattened, to scattered uniseriate; mouths oval and crossed; biseriate pitting not seen; tangential pits present at end of annual ring.

This wood is a pyritized charred specimen but it is nevertheless well preserved. The rays have largely lost their horizontal and terminal walls, but their lateral area is clearly imprinted on the tracheids, thus offering all the essential markings. In tangential aspect the cavity which now occupies their previous position has often been widened out to a fusiform shape due to the expansive effect of the crystalized pyrites. The lack, or poor development of annual rings is to be noted. This is not a hard and fast *Brachyoxylon* character, for in *B. comanchense* from Texas rings are clearly defined though the summer wood is meager. This cannot be a feature due to the geographical or geological disjunction of the species, since in *Paracupressinoxylon trinitense* from the same level in Texas, rings are wholly absent. The lateral ray-pitting is clearly discernible and in the form of the pit openings this species resembles *Brachyoxylon notabile* Jeffrey. Most of the bordered pits are contiguous and flattened though spacing is not rare. I have not detected biseriation even at the ends of tracheids.

Plate 13, fig. 47.—Transverse section to show the prevalent resin-blocked tracheids.

Fig. 48.—Radial section to illustrate the distinctive pitting. On one side is a ray on whose lateral tracheid-fields the pits stand out sharply. The small, square, dark spots scattered through the tracheids are pyritohedrons of iron disulphide.

Brachyoxylon raritanense, sp. nov. Collected in Cretaceous Raritan Clays, Matteawan, New Jersey.

PARACUPRESSINOXYLON Holden.

Paracupressinoxylon Holden, Annals of Bot., vol. 27, p. 537, 1913.

Wood parenchyma present and diffuse. Ray-cells thin-walled and pitted only on the lateral walls with a few oculipores. Resin canals present or absent. Tracheidal pits usually as in *Brachyoxylon*. Bars of Sanio not present.

Paracupressinoxylon cupressoides Holden.

Cr. Rar. N. J. 2.5.

A.R. Obscure; summer wood only a few cells thick and with slightly smaller tracheids.
R.C. Not seen.
W.R. Mostly uniseriate, usually from two to twelve cells deep, slightly resinous, lateral pits one or two oculipores per tracheid-field with lenticular elongate mouths.
W.P. Abundant, resinous, diffuse. Wounded areas exhibit strongly sclerotic wood parenchyma but no resin canals either at or near the wound.
T. Pits mostly uniseriate, spaced; mouths broadly lenticular.

The wood, in the larger use of the term, is a *Cupressinoxylon*, since in addition to the abundant wood parenchyma it possesses a wounded area in which there is no trace of traumatic resin canals. In this particular specimen the rays are often destroyed by pyrites which have widened their cavities into lenticular gaps. The wood-parenchyma cells are large and filled with vesicular resin; they stand out sharply in all the sections, because of their darker color. Part of our specimens came from a large, much-pyritized stump in a clay-pit of the Avery Brick Company at Matteawan, New Jersey. The wood is traversed by numerous worm borings, and the cylindrical cavities are bordered with wound parenchyma and are often filled with amber-like resin.

We have compared this specimen with the descriptions and figures of *Paracupressinoxylon potomacense* Sinnott and Bartlett, but there are differences between them which make strict identity impossible. That species has low rays (one to three cells high) and traumatic resin canals, while traumatic stimuli in our specimens lead, so far as we have seen, to the formation of parenchyma only. Miss Holden (1914), however, has described from Cliffwood, New Jersey, fragments of lignite identified with *Paracupressinoxylon cupressoides* Holden which she discovered in the Jurassic deposits of Yorkshire (Holden, 1913b). Our wood is undoubtedly the same, for even as in that species the rays are thin-walled and no resin canals have been seen. As to Holden's *Paracupressinoxylon cedroides*, we are of the opinion that the possession of thick-walled abietean rays is a character sufficient to justify the founding of a new genus. Since the thin-walled *Paracupressinoxylon cupressoides* was published at the same time as the thick-walled *P. cedroides* the rule of priority does not interfere with the transference of the latter to a new genus for which we propose the name *Metacupressinoxylon*. The Yorkshire wood now becomes *Metacupressinoxylon cedroides* (Holden) n. comb. The generic diagnosis follows.

METACUPRESSINOXYLON, GEN. NOV.

Wood parenchyma present and diffuse; traumatic resin canals present. Wood rays thick-walled and heavily pitted with small lateral oculipores. Tracheids beset with uniseriate spaced, or biseriate alternating, bordered pits. Medulla homogeneously parenchymatous.

Since making the above change we have been gratified to find that Professor Seward writes, "The species *P. cedroides* should not, in my opinion be included with *P. cupressoides* in one genus."

Plate 14, fig. 49.—Paracupressinoxylon cupressoides Holden. This figure shows the presence of wood parenchyma in the unmodified wood below, while the wounded area is introduced to prove that a traumatic stimulus does not induce the formation of a schizogenous resin canal, for only sclerotic parenchyma intermixed with abundant thin-walled resinous cells is visible.

Fig. 50 is from a radial section through one of the borings of which we have spoken. Bordering the wound there can be seen a dark band of resinous parenchyma, while farther out the highly disturbed tracheids of the wood are visible.

Paracupressinoxylon cupressoides Holden. Specimens collected in Cretaceous Raritan clays, Matteawan, New Jersey.

Paracupressinoxylon trinitense, sp. nov.

Co. Tex. 2. 123.

A.R. Seemingly quite absent. (To the naked eye faint bands are visible.)
R.C. Not seen.
W.R. Average from two to twelve cells deep, not highly resinous; terminal and horizontal walls unpitted; lateral tracheid-field with one or two oculipores with lenticular openings, these sometimes widening to oöpores.
W.P. Present but not abundant.
T. Pits mostly scattered and round with large oval mouths; bars of Sanio absent.

In cross-section this wood is very brachyoxyloid, for its tracheids are much of the same size throughout, and annual rings are not evident under the microscope. The wood parenchyma is uncommon but its presence suffices to indicate that the wood is not one of the *Brachyoxyla*. The lateral ray-pits not infrequently widen out to true oöpores. This might suggest a reference of the wood to *Paraphyllocladoxylon* Holden, but it is such a fluctuating character that we prefer to retain such specimens in a single genus.

This wood is different from most of those which characterize the Comanchean deposits of Texas. The preservation is excellent, but we have searched in vain for any evidence of the presence of bars of Sanio, and are forced to believe that they were not present. We have been very cautious about employing this piece of negative evidence alone to distinguish between abietean and araucarian woods. Here, however, there is a positive character which militates against a reference to the genus *Cupressinoxylon*, in which an abietean wood of this character would be placed. The annual rings are scarcely discernible; this is an araucarian character. That the absence of rings is not due wholly to climatic conditions is proved by the fact that other woods from the same deposits have them well developed. Taken in conjunc-

tion with the absence of bars there can be little doubt that we are dealing with an araucarian wood,—a member of the tribe Araucarieae.

Comparison with *Paracupressinoxylon potomacense* Sinnott and Bartlett (1916) is of interest since that wood is derived from the Potomac strata which are generally supposed to be of the same age as the Trinity deposits of Texas. The resemblances are extremely close and, in fact, are only such as might separate allied species. *P. potomacense* has poorly developed annual rings, uniseriate bordered pits, one or two ray-pits per lateral tracheid-field and low rays. The differences lie in the deeper rays of our specimen (up to twelve cells) with a tendency to form oöpores; and in the traumatic resin canals of the eastern species. As a parallel to *P. potomacense* we may well name our wood *P. trinitense.*

Plate 14, fig. 51.—Transverse section to show the homogeneity of the wood with the absence of annual rings and the sparsely distributed wood parenchyma.

Paracupressinoxylon trinitense, sp. nov. From Comanchean Trinity deposits, Weatherford, Texas.

TELEPHRAGMOXYLON[1] TORREY.

Synonomy as for *Araucarioxylon.*
Telephragmoxylon Torrey, Annals of Bot., vol. 35, p. 73, 1921.

Annual rings evident; resin canals traumatic in the vertical direction. Wood rays uniseriate, or partly biseriate; lateral pits from few to many small oculipores per tracheid-field, other walls thin and unpitted. Wood parenchyma none. Tracheids of two kinds: normal and septate, the latter confined to the end of the annual ring and divided into short segments by cross-walls which bear bordered pits. Radial pitting of the tracheids uni- or biseriate, contiguous and flattened; when in more than one row, alternating. Tangential pitting abundant. Medulla interspersed with masses of sclerites.

Telephragmoxylon brachyphylloides, sp. nov.

Co. Tex. 1.5. and 1.11.

A.R. Evident but not striking.
R.C. Traumatic in the vertical direction.
W.R. Uniseriate or biseriate in old wood; from two to sixteen cells deep, slightly resinous, lateral tracheid-field with few to ten small oculipores, with oval to circular openings.
W.P. None.
T. Pitting in young wood uniseriate, contiguous and flattened, in older wood often biseriate, alternate, contiguous; or sometimes in two rows, but the rows slightly separated. Pit mouths elongate, oval and crossed. Terminal tracheids of an annual ring (best seen in tangential or transverse section) septate.
M. With nests of stone-cells.

[1] Dr. Kräusel (Paläobotanische Notizen, Senckenbergiana, vol. 3, part 5, p. 138–139, Dec. 1921) has taken exception to the genus *Telephragmoxylon* on the ground that the septate tracheids are due to traumatism. Before instituting the genus this possibility was fully considered but no evidence in its favor could be found. Surely it would be a strange thing if a tree suffered annual wounding which invoked the formation of septate tracheids at the end of each annual ring and around the whole periphery.

In an article (Torrey, 1921) published some months ago we called attention to this new wood. It is one of the most interesting we have discovered and offers a striking confirmation of a theory whose best discussion is to be found in Jeffrey's Anatomy of Woody Plants. It is there contended that wood parenchyma was derived historically from tracheids which first of all underwent segmentation and later, through loss or non-development of the secondary thickening layer, were converted into wood parenchyma. Not only does parenchyma, then, have its genesis in tracheidal tissue but its first appearance is held to have been among the summer tracheids at the ends of the annual rings, where it is in some way correlated with the resumption of active growth at the beginning of the next season. This view was derived from comparative anatomical investigation among the Abieteae, where root wood of the genus *Picea* in particular exhibits at the end of its annual ring all stages of transition from septation of ordinary thick-walled tracheids through conditions of interspersed thick- and thin-walled moieties of a single tracheid, to complete parenchymatization.

In the wood now under consideration,—a Comanchean fossil araucarian,—a stage in the septation process never before observed is strikingly manifest: at the end of the ring nearly every tracheid is crossed by diaphragms in which bordered pits are as evident as they are on the radial or tangential walls. As to the physiological significance of this phenomenon Professor Jeffrey has suggested that it might be a mechanism for retarding the rapid upward movement of water in the spring and thus facilitating its radial distribution to the developing cambium. There is no evidence whatsoever of protoplasm or other matter in these short tracheids, hence it is evident that the storage function had not yet been attained.

Wood parenchyma has originated independently in at least two coniferous lines: the pine-abietean and the araucarian. In the former the incipient stages still persist in the older genera; while among the araucarians it has originated several times. Thus it occurs fully formed in the Jurassic *Metacupressinoxylon cedroides,* its inception is witnessed in the Comanchean *Telephragmoxylon,* while it may have had a separate origin in *Paracupressinoxylon.*

If Gothan is right in assigning *Dadoxylon* (*Araucarioxylon*) *spitzbergense* Gothan to the Triassic period, we must believe that wood parenchyma is of far more ancient origin than we had supposed, but we are aware that the age of the strata in which this wood was found has been called in question. In all likelihood it is not older than the Jurassic or Cretaceous and then it takes its place in the genus *Araucarioxylon* (in the restricted sense). Gothan himself is a bit puzzled by his specimen for he says: "Diese Vorkommen [wood parenchyma] bildet für Hölzer von rein araucarioider Struktur etwas Besonderes, denn bei lebenden Araucarieen wie bei fossilen ist es nur höchst selten und nur vereinzelt zu finden, so dass es praktisch als fehlend zu bezeichnen ist." It should be remembered that among "fossilen Araucarieen" Gothan includes the *Dadoxyla.* It seems hardly probable that among the many known woods from the Triassic period which are so conspicuously characterized by the complete absence of parenchyma, one specimen only should be found with parenchyma in a diffuse condition.

As to Caspary's *Araucariopsis macractis,* which was separated from *Dadoxylon* because of its

possession of wood parenchyma, the age is unknown and Gothan merely suspects that it is Palaeozoic or early Mesozoic on the evidence of the "Jahresringesverhältnisse." The presence or apparent absence of annual rings, however, is a very insecure single criterion on which to base the age of a wood. It is probably a true *Araucarioxylon*.

In the literature we know of only one instance in which the normal septation of the tracheids at the end of the annual ring has been noted. Among the Jurassic Coniferae from Yorkshire studied by Miss Holden was a species of *Brachyoxylon* in which the same feature was seen, but the significance of the discovery was not recognized at the time. This wood should now be included in the genus *Telephragmoxylon*.

The reference of our interesting genus to the Brachyphylleae is based on its wound reactions, its sclerotic pith, the pitting of its younger wood, and the lateral ray-pitting which is very similar to that of the contemporary *Brachyoxylon texense*.

Plate 14, fig. 52.—Transverse section; detail of septate tracheids. In this highly magnified view the remarkable phenomenon which sets the genus apart is seen. Stretching obliquely across the field is a darker band of tracheids. The dark color is due to the fact that a lucky section has cut at least five tracheids in succession at such a point that their cross-walls are visible. On one of these septa a pair of bordered pits is clearly seen, and evidences of the same are visible on three more.

Fig. 53.—Tangential section. This section is cut slightly out of the tangential plane and inclines just enough toward the transverse to exhibit the tracheids at the end of the annual ring. These run in an oblique band across the field. It can be seen that practically every tracheid is septated by double parallel lines which represent the faces of two bordered pits from between which the middle lamella has disappeared. Even under the low magnification it is plain that just as was evidenced by Fig. 5 (Plate 8) there are sometimes two pits per septum.

Fig. 54.—Here under higher magnification the double pits of the septa are strikingly evident and the presence of tangential pits with which these "fragmented tracheids" are always liberally provided, is also to be noted.

Fig. 55.—Is introduced to show the araucarian nature of the tracheidal pitting of this new wood.

Telephragmoxylon brachyphylloides, sp. nov. Specimens from Comanchean deposits, Weatherford, Texas.

Telephragmoxylon comanchense, sp. nov.

Co. Tex. 2. 121.

A.R. Limits of annual ring marked by a zone of summer wood three or four cells wide. Spring wood coarse.

R.C. Traumatic, vertical.

W.R. Uni- or biseriate; few to twenty cells high (average eight to ten cells), very resinous, variable in shape and size; often large and bulging in part. Lateral pits few to many per tracheid-field, oculipores with oblique slit-like openings.

W.P. None.

T. Large, interspersed with resin-filled tracheids related to the rays. Septate tracheids few at the end of the annual rings. Bordered pits somewhat variable in size and arrangement uniseriate, or biseriate alternate, usually contiguous, sometimes irregularly opposite; mouths oval, oblique and crossed.

The heavily resinous rays are correlated with the resin-filled tracheids which often border them. Similar resinous tracheids are characteristic of the living araucarians. The rays

themselves are very striking in tangential aspect, not only because of their dark-colored contents, but because they vary in depth and tend to assume odd forms due to their swollen cells and the mixture of uni- and bi- and even triseriation in the same ray. Their lateral oculipores differ in their slit-like openings from those of *T. brachyphylloides* where they are oval to round.

The septate tracheids at the end of the annual rings are far less numerous than in the last species. Their paucity made it questionable whether it might not be best to retain the wood in the genus *Brachyoxylon*, but since other characters are also similar to those of *Telephragmoxylon*, a reference to the latter is probably more desirable. In this species is seen a transition from an antecedent *Brachyoxylon* condition to the condition found in *T. brachyphylloides*. Of course it is possible to interpret these two *Telephragmoxyla* in the reverse order and to look upon the one as the degraded condition of the other, but it seems more probable that the series is a progressive one.

Plate 14, fig. 56.—This figure of the traumatic resin canals is introduced to show the brachyoxyloid nature of the wood.

Plate 15, fig. 57.—Transverse section of normal wood. The evident annual rings and highly resinous rays are to be noted.

Fig. 58.—Tangential section. Again in this section appear the rays composed of swollen resinous cells. Certain tracheids are traversed by fungal hyphae which may be seen piercing their walls.

Fig. 59.—Here is shown the significant diagnostic feature: two tracheids exhibit septation. In addition tangential pits are visible and also the bulky resinous rays.

Fig. 60.—Radial section. The bordered pits in this figure are less modified by pressure than is the case in *T. brachyphylloides* though this is not a constant feature as is proved by the next figure. On one of the ray-cells a dark, oval marking represents an uncommon coronal arrangement of the oculipores.

Telephragmoxylon comanchense, sp. nov. From Comanchean sands, Weatherford, Texas.

ARAUCARIOXYLON Kraus.

Dadoxylon Endlicher, Synops. Conif., 1847.
Araucarioxylon Kraus, Sitzungsb. d. Naturf. Gesellsch. Halle, 1882.
Cordaioxylon Felix, Untersuch. über d. inn. Bau. westfal. Carbonpflanzen, 1886.
Cordaioxylon, various authors.

Annual rings usually obscure. Resin canals neither normal nor traumatic. Wood rays usually uniseriate; thin-walled, with a few to many small oculipores on the lateral tracheid-fields. Resinous wood parenchyma diffuse (in the living genera confined to conservative regions). Tracheids marked with uni- to multiseriate contiguous bordered pits; when in more than one row, typically alternating; bars of Sanio wholly wanting. Leaf-traces persistent.

Araucarioxylon texense, sp. nov.

Co. Tex. 1. 10.

A.R. Obscure.
R.C. None.
W.R. Two to ten cells deep (about six common), resinous, uniseriate, with several to many oculipores per tracheid-field.
W.P. Abundant, diffuse and heavily resinous.

T. With oval to rounded lumina; bordered pits usually contiguous, uniseriate and flattened. More rarely biseriate and alternate.
Leaf-traces persistent.

The obscurity or lack of annual rings in this wood is a feature which has long been held to be of diagnostic value for the genus *Araucarioxylon*. There is no evidence of their presence in this specimen.

The preservation leaves much to be desired, for the structural changes which it has undergone have given an appearance similar to that of *Araucarioxylon noveboracense* Jeffrey (1912) from the Cretaceous deposits of Staten Island. Thus in both, the tracheid walls are swollen and the lumina are filled with granular or vesicular matter; both manifest the same characteristic deep-brown resinous parenchyma, although in our specimen from Texas this is more abundant than in the Staten Island species, and is so well preserved as to show its cross-walls very clearly in radial sections.

The tracheidal pitting is possibly another character on which the species are to be separated, since it is more commonly biseriate in *A. noveboracense* than in *A. texense*. On the whole, however, the wood of the former is more robust and this may account in some degree for the prevalent biseriate pitting. The persistence of the leaf-traces in our specimen is another feature which insures the correctness of our reference to the genus *Araucarioxylon*, and proves that the specimen is from stem wood.

There are certain features of this Comanchean *Araucarioxylon* which may be correlated with its greater age. We hold that the Araucariaceae represent a degrading series whose origin is to be sought among the Abieteae and whose gradual path of evolution is rather clearly marked in the successive subtribes, Araucariopityeae, Brachyphylleae and Araucarieae. As a primitive member of the last subtribe we should expect this wood to show features now confined more particularly to the conservative organs of living genera of araucarians. And this is exactly the state of affairs, for not only is its pitting simpler and more brachyoxyloid, but it possesses abundant diffuse parenchyma in its stem wood. Thus it manifests characters which in living genera are confined almost wholly to root or first annual ring or to reproductive axes. The modern araucarians, then, have lost the parenchyma which was present in the cauline region of their ancestors, and their bordered pits have become multiseriate. They exhibit, so to speak, the second childhood of their remote ancestors, the *Dadoxyla*.

Plate 15, fig. 61.—Transverse section. This shows the unmistakable wood parenchyma scattered among the tracheids. In many cases the transverse sections of bordered pits are visible.

Fig. 62.—Tangential section. In the center of the field lies one of the persisting leaf-traces. With a hand-lens the tiny tracheids of the trace itself are visible.

Fig. 63.—Radial section. This is photographed to show the wood parenchyma in detail. It is evident that here are two heavily resinous parenchyma cells separated by a delicate transverse septum.

Fig. 64.—Radial section; detail of pitting. The wood is not charred and so its preservation leaves much to be desired, but on the tracheid to the left of center the alternating and distinctive araucarian pitting is clearly shown.

Araucarioxylon texense, sp. nov. From Comanchean deposits, Cottondale, Texas.

Summary of Species.

In the systematic part of this paper just finished, twenty-two species of fossil coniferous woods are described. Of these, sixteen are new or at least have not been identified with other known species. The list of species and their distribution by States is as follows:

Colorado:	*Sequoioxylon Burgessii* (Penhallow) comb. nov.
Massachusetts:	*Brachyoxylon woodworthianum*, sp. nov.
Montana:	*Sequoioxylon montanense*, sp. nov.
Nebraska:	*Dadoxylon*, sp.
New Jersey:	*Pityoxylon scituatensiforme* (Bailey) comb. nov.
	Podocarpoxylon McGeei (Knowlton) Sinnott and Bartlett
	Brachyoxylon raritanense, sp. nov.
	Paracupressinoxylon cupressoides Holden
North Dakota:	*Pityoxylon*, sp.
	Podocarpoxylon dakotense, sp. nov.
	Sequoioxylon dakotense, sp. nov.
	Sequoioxylon laramense, sp. nov.
Oregon:	*Pityoxylon* cf. *Vateri* Platen.
	Pseudotsuga annulatum (Platen) comb. nov.
Texas:	*Voltzioxylon dockumense*, gen. et sp. nov.
	Podocarpoxylon texense, sp. nov.
	Brachyoxylon comanchense, sp. nov.
	Paracupressinoxylon trinitense, sp. nov.
	Telephragmoxylon brachyphylloides, sp. nov.
	Telephragmoxylon comanchense, sp. nov.
	Araucarioxylon texense, sp. nov.
Washington:	*Podocarpoxylon washingtonense*, sp. nov.

GENERAL SUMMARY AND CONCLUSIONS.

Having finished the descriptions of the species of fossil woods, there remains only one task: to summarize the work and to draw conclusions. This can best be done through an attempt to trace the phylogeny of the main lines of the Coniferales, in so far as they are becoming evident through our improved understanding of the remains. The correlative and highly important evidence presented by impressions can be but slightly touched upon. The value of such evidence is recognized but it is a science with which we are not competent to deal, and furthermore, very little has been done in the way of correlating the structural remains and the impressions of Mesozoic plants.

The Derivation of the Coniferales.

That the conifers rose from the Cordaitales is no longer to be doubted. Among the Cordaitales is found the main theme, so to speak, on which the later coniferous variation was based. It will therefore be of value to begin with a consideration of the distinctive features of this ancient order of gymnosperms.

The Cordaitales had departed rather widely from their fern-like ancestors in their general habit as well as in their anatomy. They had developed the shaft-like stem and the simple

elongate leaf. These features were to be carried on by their descendants. In them were witnessed, too, the last stages and final disappearance of stelar centripetal xylem. The ancient heavily pitted tracheid was retained, but there had been a great reduction of ray-tissue, so that instead of the spongy stele of the cycad allies, there was now a strong woody cylinder such as is familiar to us in modern conifers and in *Ginkgo*. In leaf anatomy their bundles, surrounded by sheaths of transfusion tissue, retained the mesarchy of their ancestors. Last of all the fructifications showed a significant modernization, since the seeds were borne on secondary axes of the strobilus even as in *Pinus*. Renault's figures of the female strobilus of *Cordaites* have long been familiar. An even more striking exhibition of the short-shoot character has recently been figured by Berry (1920, p. 354) who shows a *Cordaianthus* bearing ovules on brachyblasts which are beset with pine-like needles. The figure should be compared with that of *Prepinus* Jeffrey (1908), or of *Pityites Solmsii* Seward (1919). We must thank Professor Berry for a new piece of evidence for the "ingenious hypothesis" that the pines came directly from the Cordaitales. Very unfortunately the immediate descendants of the Cordaitales are scarcely known. During the Triassic and Jurassic periods, just when a significant modernization was taking place, the conditions for the preservation of structural material were so unfavorable that few fragments have come down to us to tell of the road along which the gymnosperms were moving. But the fragments, few though they be, when taken in conjunction with our "living cordaite," *Ginkgo*, offer a body of evidence which like a guide-post points the way to the Abieteae.

Perhaps the most cordaitean of the fragments is *Woodworthia* Jeffrey (1910a), a wood which had the tracheidal markings and the ray structure of its ancestors, but possessed in addition persisting brachyblasts whose elongation followed their progressive sealing-in by the radial growth of the trunk, and which must have borne their leaves in a spiral phyllotaxy, since in their radial passage through the trunk wood they are beset with numerous departing leaf-traces. Thus they manifest the brachyblastic condition in its ancient form. At the highest state of its development this has become the abbreviated shoot with sheathed needles so characteristic of the pines.

Woodworthia retained the ancient histological features of its parents, but in *Voltzia*, another Triassic fossil, variously considered by palaeobotanists as a cupressean, a taxodian and an araucarian, the cone anatomy lies far from the Cordaitales as we know them, and rather recalls that of the Abieteae. On the other hand, the wood structure is still cordaitean in the broad sense of that term, since, although the pits have broken the formalistic line-up of *Dadoxylon*, they are still individually of the same type, with tiny oblique cross-mouths and without trace of bars of Sanio. Moreover, the rays are cordaitean. Woods of the *Voltzioxylon* type have been found in Nova Scotia, Texas, Sweden and Russia, while the impressions of the genus *Voltzia* are spread over the earth.

In the last section of this paper we shall point out that *Ginkgo*, an admitted cordaitean derivative, bears many significant anatomical resemblances to *Pinus*.

The Phylogeny of the Abieteae.

The evidence, then, which may be assembled from the all too few Jura-Trias fossils and from *Ginkgo,* points sharply to the Abieteae as the group foreshadowed, and in the Cretaceous period this prophecy passed into full revelation. This seeming sudden efflorescence of conifers is not so in fact, for it must not be forgotten that in the closed volumes of Triassic and Jurassic history there are many pages upon which the story of early abietean evolution was written. During those long ages the ancient cordaitean stock was slowly moulded into the abietean. That the changes conduced to a perfected mechanism well adapted to the conditions of the environment is well assured by the continued persistence of the pines and their representation in no negligible degree among the living conifers. But never after the Cretaceous period did they possess such a complicated anatomical organization.

Among the Cretaceous pines the remarkable genus *Prepinus* Jeffrey demands special consideration. The plant is known from its sturdy brachyblasts which are thickly beset with scales below and with many needles above. In the structure of the needles the retained cordaitean features are strikingly manifest: for not only is there seen the double sheath of transfusion tissue around the vascular strand, but the xylem of the trace itself is partly centripetal.

Professor Seward has recently questioned the statements concerning the resemblance of the *Prepinus* needle to the leaf of *Cordaites principalis.* But surely equivalent sequence and histological identity of tissues in homologous organs must be accepted as valid criteria of affinity between allied plants if there is no evidence of parallelism or other disturbing factors to militate against it.

Two lines of evolution rose from the ancient pinean stock: one to deploy into the modern Abieteae, Taxodieae, Cupresseae and probably Taxaceae; and the other to produce the rich araucarian complex. Jeffrey's studies have shown that the living Abieteae fall naturally into two subtribes,—the Larinae, most highly specialized and yet most primitive, which includes *Pinus, Picea, Pseudotsuga* and *Larix;* and the derived and regressive Abietinae which embraces *Abies, Cedrus, Pseudolarix* and *Tsuga.*

Cupresseae and Taxaceae.

From the Abieteae arose the further simplified Cupresseae. Their elaboration requires but the progressive development of parenchyma which had already begun to diffuse in certain Abietinae, along with the continued degradation and final disappearance of resin canals. The podocarps and taxads may also have had an abietean origin. Their wood anatomy is on a level with that of the Cupresseae, while their female strobili show evidences of reduction.

Unfortunately Gothan's genus *Podocarpoxylon* can be held to have little systematic significance. We know little concerning the actual history of the group. Sinnott following Jeffrey and Chrysler has argued for a podocarpinean intermediation between the Abieteae and the Araucariaceae.

The Taxodieae or Sequoieae.

From the pines still another line of evolution led to the sequoias. Two species of the genus *Sequoia* survive: *Sequoia washingtoniana* (Winsl.) Sudworth, and *Sequoia sempervirens* (Lamb.) Endlicher. Both produce traumatic resin canals, and the former has normal canals in conservative regions. These retentive and reversionary characters point directly back to an ancestor in which they were normal features of the wood.

We have realized for some time that horizontal resin canals are the first to show the degenerative effect in a regressive stock, and that they may pass into a condition of latency while the vertical canals are still fully functional. This is witnessed in the genus *Protopiceoxylon* Gothan. Later they may be lost altogether, as is the condition of all the abietean woods except that of *Cedrus*, which standing closer to its parent stock than its relatives, exhibits well-formed traumatic canals in both directions.

In a considerable number of species of sequoia wood from the Laramie deposits, we have been so fortunate as to find wounded material, and in them wound resin canals are present in *both* directions. The implications of this fact should be evident, namely, that the *Sequoioxyla* were derived from the pines in which normal resin canals run in both directions. As recently as in Cretaceo-Eocene time, the *Sequoioxyla* stood near enough to their ancestors to produce traumatic resin canals in both directions. Significantly enough the Upper Miocene *Taxodioxylon* (*Sequoioxylon*) *sequoianum* (Merck.) Gothan and the two living species of *Sequoia* have passed a step farther. One of the latter not only shows vertical wound canals but testifies to its origin in retaining normal resin canals in "peduncle, axis, and scales of the female cone" as well as in the first annual ring of vigorous branches. *Sequoia sempervirens*, on the other hand, has lost all trace of normal resin canals.

One point of some economic importance demands consideration. It begins to appear that the great Tertiary economic lignite or brown-coal deposits of the world are formed largely of sequoia wood. Yasui (1917) has reported such a wood from the Tertiary coal-fields of Japan. Kräusel (1918) finds several probable sequoia woods,—*Taxodioxylon taxodii* Gothan, and *Cupressinoxylon wellingtonoides* (Prill) Kräusel,—abundant in the German mines. Our American Laramie lignites offer a strong *Sequoia* facies while the wood called *Podocarpoxylon texense*, which forms the basis of the Texan lignites, seems to be of sequoian affinity. How many sequoias are lost in the literature under the name *Cupressinoxylon*, no one can say.

The Araucariaceae.

We now approach the great battle-ground of coniferous phylogeny. We may state the problem briefly: Did the araucarians come from the Cordaitales or did they come from the pines? In other words which is the most ancient group of conifers?

On the face of the matter there seems to be but one answer. The woods of the araucarians cannot be distinguished from those of the Cordaitales. Such is Gothan's opinion and so he places both types of wood in the form-genus *Araucarioxylon*. Pitting is identical on rays and

tracheids; both (seemingly) lack resin canals and wood parenchyma. Surely one must have striking evidence to the contrary to oppose such obvious facts and to argue that the araucarians came, not from the Cordaitales but from the pines.

Progressive and Regressive Series.—Many years ago, in a work on fossil cephalopods, Alpheus Hyatt pointed out that these organisms in their phylogeny seemed to progress from a state of simplicity to complexity only to fall back through regressive stages to a simple condition again. Briefly, he came to see that the Cambrian straight-shelled, ancestral genus *Orthoceratites* rose through many genetic series of *Cyrtoceros, Gyroceros,* and nautiloid forms till a highly coiled shell came into being. Alongside the coiling process were progressive changes in septal suturing and opening of the shell-mouth. Arrived at extreme complexity the regressive process set in until in the Cretaceous period the genus *Baculites* appears with a simple straight shell so like that of its Cambrian ancestor that some geologists had actually classified the two in the same genus. Hyatt further pointed out that the Biogenetic Law was perfectly illustrated in the extreme genera, whose successive ontogenetic stages were fixed as the shells increased in size. An analysis of Hyatt's work will be found in Cope's Origin of Genera. The principle just discussed has been called orthogenesis.

In recent years biologists have been averse to trusting to the inductive method in deriving such broad generalizations. Perhaps biology has suffered thereby,—certainly its appeal to the imagination has lessened. No one who has worked much in plant morphology from the newer evolutionary point of view, particularly if he has taken the fossil evidence into consideration, can have failed to note what appears to be the sweep of the same orthogenetic law.

Hypothetical Precarboniferous herbs passed into tree forms, only to sink back to herbs in recent time. Ferns have "concentric closed bundles,"—so do monocots,—and yet what sane botanist today thinks of any close affinity between them? Modern Magnoliaceae have scalariform pits on their tracheids and yet Bliss has recently established beyond a doubt that these have resulted from fusions of bordered pits in rows and are totally unrelated genetically to the condition found in cycads. Such pitting can no longer be used as a point in favor of the bennettitalian affinity of the Ranales (Bliss, 1921). The regressive part of the same process seems to be running today among the conifers. *Woodworthia, Prepinus, Pityites Solmsii,* and a recently discovered and as yet undescribed three-needle pine from the Cretaceous lead finally in modern times to the reduced *Pinus monophylla.*

From a parallel course of reasoning I believe that the araucarians represent the extreme regression of the pine series, and that their supposed cordaitean features are senile and coenogenetic characters.

Palaeontological Evidence of Phylogeny.—The pines run back at least to the Triassic period, certainly as far as the araucarians. There is no palaeontological evidence that they are a modern group which arose from the latter. The earliest-known woods of araucarian affinity were discovered by Gothan in Jurassic deposits of Spitzbergen. They are so abietean, that is,

so little modified from their ancestral state, that, basing his reference on the heavily pitted ray-cells, he classifies them with the Abieteae in spite of the fact that they bear araucarian tracheidal pitting. The most primitive of these woods is *Protopiceoxylon* (an example of most unhappy taxonomy). It is a wood in which the degenerative process is just beginning. While we are perfectly willing to let Gothan classify this wood with the Abieteae, we insist that it be considered a protoaraucarian since we believe that it is an abietean conifer not far enough removed from the pines to have fully lost its resin canals and abietean rays. Its pits, however, have taken on the araucarian arrangement, or if one prefers, they have reverted to the *Dadoxylon* condition.

The character of the pitting of tracheids is by no means a stable one. Fluctuations between the two types are not uncommon in fossil woods. An instance of this may be seen in *Cupressinoxylon Walkomi* Sahni (1920) and in the wood we describe as *Podocarpoxylon dakotense*. The transition from araucarian to abietean pitting is easily effected in the ontogeny of *Ginkgo* or of *Brachyoxylon*, while the reverse is seen in the cone axis of *Araucaria*. In the latter the early-formed tracheids bear a definite biseriate opposition of bordered pits. Miss Holden observed the same phenomenon in the young wood of fossil araucarians. We must protest most vigorously against the name Protopinaceae which Kräusel (1918a, 1920) suggests for these transitional woods. Certainly if they are to be elevated to the rank of a family they should be given a name which commits us to no phylogenetic theory.

Araucariopitys Jeffrey may be said to stand next in line with *Protopiceoxylon*, for its horizontal resin canals are lost even beyond traumatic recall, while the vertical canals have slipped into a state of latency and only reappear under the stimulus of wounding. Like *Protopiceoxylon*, however, it still retains the heavily pitted rays of its ancestors.

We differ from Penhallow and Gothan in our interpretation of the significance of wound resin canals. For whereas they see in such structures "Anpassungsmerkmale," prophetic of future conditions, we interpret them as reversionary phenomena. If Penhallow and Gothan are right then, to take a striking case, the *Sequoiae* of the Eocene period were false prophets. They were obviously "predicting" that their descendants were to have resin canals in both directions like a pine. Yet *Sequoia washingtoniana* and *Sequoia sempervirens* have resin canals developing only *vertically* when wounded. The only way out of the dilemma is to say that the living *Sequoiae* are more primitive than the fossils. If anyone should be inclined to argue this theory seriously let us ask if the normal resin canals of cone axis and cone scales and first annual ring of the root and vigorous branches are also "predictions." It should be obvious from this digression on *Sequoia* that the interpretation of traumatic resin canals as reversionary phenomena is logical and satisfactory, and that any other interpretation leads to curious inconsistencies.

With the Brachyphylleae came the next regression: some of the members of the tribe are strangely analogous in outward aspect to certain Taxodieae and yet their internal anatomy is unmistakably araucarian. We have described several new species of the genus *Brachyoxylon*

and have pointed out in some detail the very significant features which were exhibited by a young twig of *Brachyoxylon woodworthianum*. For next the medulla lie tracheids beset with *Dadoxylon*-pitting; farther out the pits exhibit an arrangement commonly considered to be abietinean, while in the trunk wood itself the tracheids are often marked with alternating, flattened, bordered pits. The wood may be said to retain the stages of its own progressive ontogeny and to illustrate clearly the biogenetic law.

The *Brachyoxyla* all retain the power to form traumatic resin canals, and along with this reaction the rays, too, near wounded regions, usually show a significant thickening and heavy "abietean pitting." But the most interesting feature which any member of the Brachyphylloideae has yet evidenced, is the septation of tracheids which is seen in the new wood, *Telephragmoxylon*. We have discussed this phenomenon in some detail under the first species of *Telephragmoxylon* described. There we pointed out how perfectly it substantiates the theory of the origin of wood parenchyma, and how closely it parallels a series of similar stages in the abietean-cupressean stock.

From the *Brachyoxyla* the advance to the true fossil *Araucarioxyla* is easy. Wood parenchyma is distributed throughout the stem (diffuse), and all evidences of resin canals have been "pushed out" of the wood. But still another step was taken: the wood parenchyma invaded root and reproductive axis but disappeared from the cauline region. As the Cretaceous and Tertiary periods advanced the araucarians retreated from the northern lands before the glacial cold, and later before a host of angiosperms, coming we know not whence. Slowly they were decimated in numbers, while the process of anatomical regression went on. Today they survive as two genera only, which possess a *cauline* woody organization so analogous to that of the ancient *Dadoxyla* that a separation from them is impossible.

The Living Araucarians.—Having discussed the palaeontological evidence leading to the belief that the araucarians are derivatives of the pines, a summary may be inserted concerning the testimony of the living araucarians themselves as to their origin.

(*a*) It is well known that the wood of the root and cone axis of these plants is well supplied with wood parenchyma. Let us again emphasize the fact that the extinct species possess abundant *cauline* wood parenchyma.

(*b*) The conservative wood of the cone axis often possesses abietean rays. It should be recalled that the tribe Araucariopityeae is founded on fossil woods of this character.

(*c*) Traumatic abietean rays are easily recalled in the root wood of araucarians while *Brachyoxylon* shows the same reversionary character in its wounded stem wood.

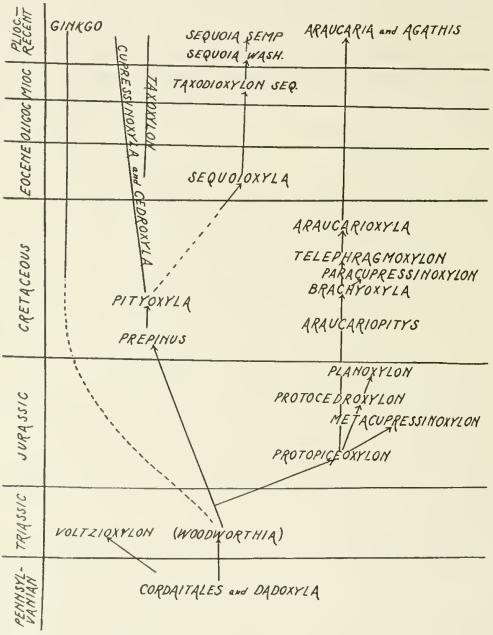
(*d*) Undoubted resin canals occur in the cone scale of *Agathis*. As is repeatedly emphasized above, resin canals were an ancient araucarian possession.

(*e*) Abietean pitting and bars of Sanio occur in the cone axis of certain living araucarians. These are pinacean features.

(*f*) Young plants of *Araucaria* do not have persistent leaf-traces, hence their persistence in the adult wood is probably not a palingenetic feature.

From the above evidence we believe we are justified in saying that the araucarians represent a series originating among the Abieteae and that they have been undergoing simplification since Cretaceous time.

Ginkgo as a Cordaitean Derivative allied to Pinus.—We have reserved till the end one piece of evidence regarding the antiquity of the pines. For some reason morphologists who argue for the derivation of Abieteae from Araucarieae are curiously averse to considering the anatomy of our "living cordaite," *Ginkgo*. We all agree that it runs back and is lost in the cordaitalian



TEXT-FIG. 1.—Phylogeny of the coniferales.

plexus. *Ginkgo* has many resemblances to *Pinus*. Its short shoots are on the primitive level of those of *Prepinus* and of *Pityites Solmsii* Seward; its male strobilus is obviously pine-like, as are also its winged microspores, its two male prothallial cells, and its endokinetic mechanism of anther dehiscence. Its tracheidal pitting is identical with that of *Pinus* even to the possession of the bar of Sanio. If *Ginkgo* came directly from the Cordaitales so did *Pinus*.

Lest anyone try to derive *Ginkgo*, too, from the araucarians we hasten to assure him that its seeds, leaves and wood-ray features are cordaitean and that the pitting of the first-formed tracheids of its root wood offers one of the most perfect and beautiful testimonials we possess as to the truth of the biogenetic law. So obvious is the recapitulation that we use slides of *Ginkgo* wood to teach this law to elementary students.

It would appear, then, that both *Ginkgo* and *Pinus* had a direct cordaitean ancestry and that all the other tribes of conifers were derived from the Abieteae.

In the appended figure an attempt is made to embody the main points of the preceding discussion in the form of a phylogenetic tree linking the major types of fossil woods together. It should be realized that any such scheme as this is only tentative; it presents the writer's views, however, and may also serve as a mnemonic system.

Acknowledgments.

In conclusion the writer wishes to express his sense of obligation to the many who have contributed to the success of this work. To a Sheldon Traveling Fellowship from Harvard University he is indebted for the necessary funds; to the courtesy of Dr. Smith of the University of Alabama in offering the use of a private library he owes part of the historical and geological material. To Dr. E. H. Barbour of the University of Nebraska he expresses his thanks for assistance and for specimens. To Mr. James Austin of the Harvard Laboratories is attributed much of the success which attended the technique of the work. But above all others is he indebted to Professor E. C. Jeffrey, whose advice, large patience, and ever-ready help with the difficult histological and photographic technique made the investigation possible.

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EXPLANATION OF PLATES.

All the figures are from photomicrographs. Detailed descriptions of each will be found in the body of the text.

PLATE 8.

Fig. 1. Transverse section of *Voltzioxylon dockumense*, gen. et sp. nov.
Fig. 2. Radial section of the same.
Fig. 3. Transverse section of *Pityoxylon scituatensiforme* (Bailey) n. comb.
Fig. 4. Transverse section of *Pseudotsuga annulata* (Platen) n. comb.
Fig. 5. Radial section of the same.
Fig. 6. Tangential section of the same.
Fig. 7. Transverse section of *Podocarpoxylon texense*, sp. nov.
Fig. 8. Tangential section of the same.

PLATE 9.

Fig. 9. Radial section with detail of ray of *Podocarpoxylon texense*, sp. nov.
Fig. 10. Radial section with detail of tracheidal pitting of the same.
Fig. 11. Same as Fig. 10.
Fig. 12. Transverse section of *Podocarpoxylon washingtonense*, sp. nov.
Fig. 13. Tangential section of wounded wood of the same.
Fig. 14. Radial section with detail of ray of the same.
Fig. 15. Tangential section of *Podocarpoxylon McGeei* (Knowlton) Sinnott and Bartlett.
Fig. 16. Radial section of the same.

PLATE 10.

Fig. 17. Radial section with tracheidal detail of the same.
Fig. 18. Same as Fig. 17.
Fig. 19. Transverse section of *Sequoioxylon montanense*, gen. et sp. nov.
Fig. 20. Tangential section of the same.
Fig. 21. Transverse section through wounded wood of the same.
Fig. 22. Radial section of the same.
Fig. 23. Same as Fig. 22.
Fig. 24. Transverse section of *Sequoioxylon dakotense*, sp. nov., through wounded wood.

PLATE 11.

Fig. 25. Tangential section of *Sequoioxylon dakotense*, sp. nov., through a traumatic resin canal.
Fig. 26. Radial section of wood of the same.
Fig. 27. Radial detail of tracheid of the same.
Fig. 28. Radial detail of ray of the same.
Fig. 29. Transverse section of *Sequoioxylon laramense*, sp. nov., through wounded region.
Fig. 30. Transverse section through summer wood of the same.
Fig. 31. Tangential section of the same showing resin canal.
Fig. 32. Transverse section of *Sequoioxylon Burgessii* (Penhallow) n. comb.

PLATE 12.

Fig. 33. Tangential section of the traumatic canal of *Sequoioxylon Burgessii*.
Fig. 34. Same as Fig. 33.

Fig. 35. Radial detail of ray of the same.
Fig. 36. Radial detail of tracheid of the same.
Fig. 37. Transverse section of *Brachyoxylon woodworthianum*, sp. nov.
Fig. 38. Transverse section of wounded portion of the same.
Fig. 39. Tangential section of same showing traumatic rays.
Fig. 40. Radial section of traumatic ray with nuclei.

PLATE 13.

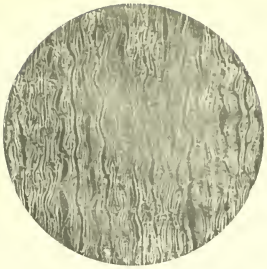
Fig. 41. Radial section of *Brachyoxylon woodworthianum*, sp. nov., with tracheid detail.
Fig. 42. Radial section through the primary xylem of a twig of the same.
Fig. 43. Radial section of later twig wood of the same.
Fig. 44. Transverse section through wounded area of *Brachyoxylon comanchense*, sp. nov.
Fig. 45. Radial aspect of traumatic resin canal of the same.
Fig. 46. Radial section to show ray detail.
Fig. 47. Transverse section of *Brachyoxylon raritanense*, sp. nov.
Fig. 48. Radial section of same to show tracheid and ray detail.

PLATE 14.

Fig. 49. Transverse section of *Paracupressinoxylon cupressoides* Holden through a wounded area.
Fig. 50. Radial section of the same through a worm-boring.
Fig. 51. Transverse section of *Paracupressinoxylon trinitense*, sp. nov.
Fig. 52. Transverse section of *Telephragmoxylon brachyphylloides*, sp. nov., showing characteristic tracheidal plates.
Fig. 53. Tangential section of the same.
Fig. 54. Tangential section of the same more highly magnified.
Fig. 55. Radial section of the same with tracheid detail.
Fig. 56. Transverse section of *Telephragmoxylon comanchense*, sp. nov., through a wounded area.

PLATE 15.

Fig. 57. Transverse section of normal wood of *Telephragmoxylon comanchense*, sp. nov.
Fig. 58. Tangential section of the same.
Fig. 59. Tangential section of the same with septate tracheids.
Fig. 60. Radial section of the same for tracheid and ray detail.
Fig. 61. Transverse section of *Araucarioxylon texense*, sp. nov.
Fig. 62. Tangential section of the same with leaf-trace.
Fig. 63. Radial section of the same with wood parenchyma.
Fig. 64. Radial section of the same for tracheid detail.



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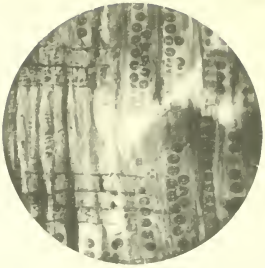

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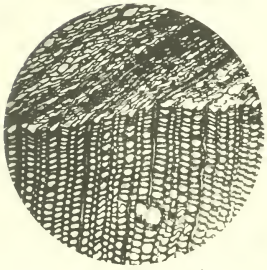

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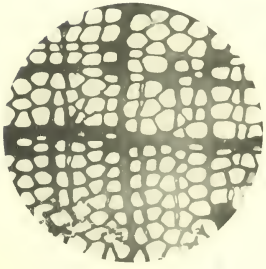

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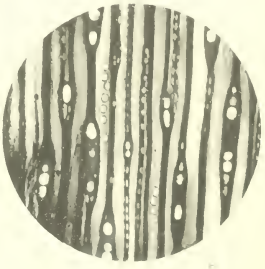

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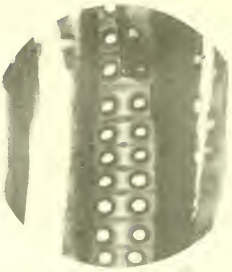
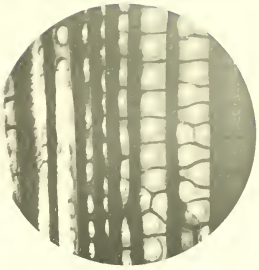
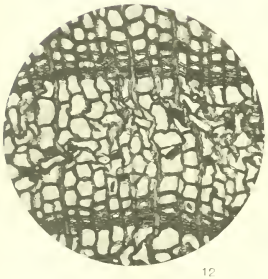
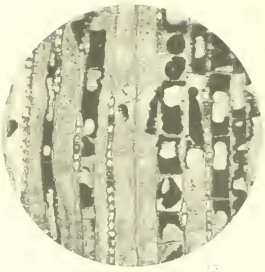
Torrey on Fossil Conifers.

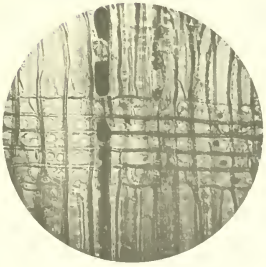
HELIOTYPE CO. BOSTON

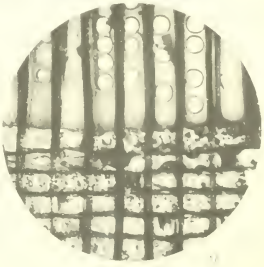












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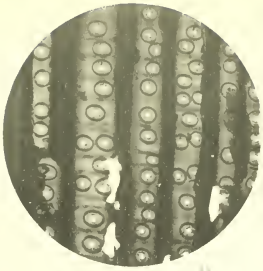

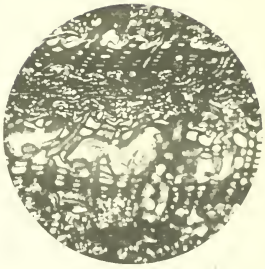

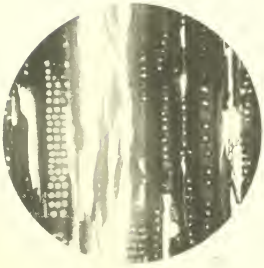

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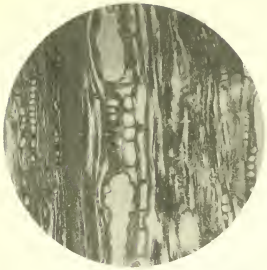

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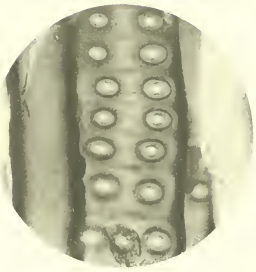

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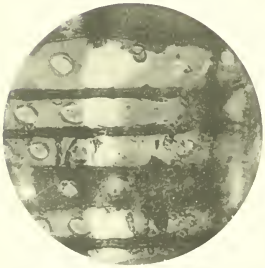

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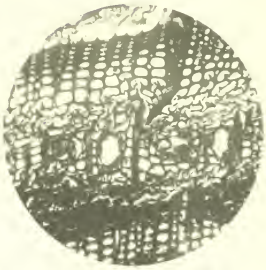

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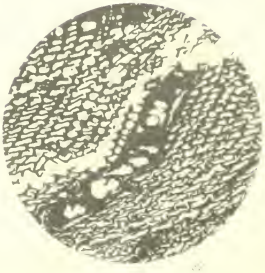

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TORREY ON FOSSIL CONIFERS.

HELIOTYPE CO., BOSTON.

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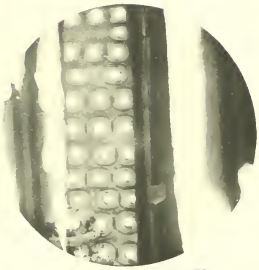

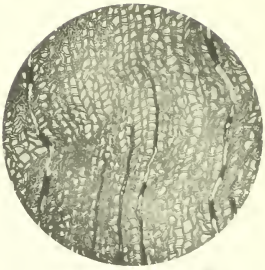

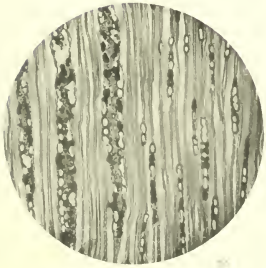

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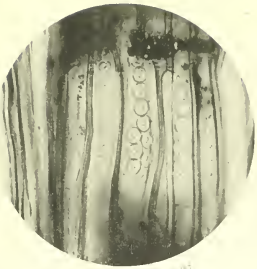
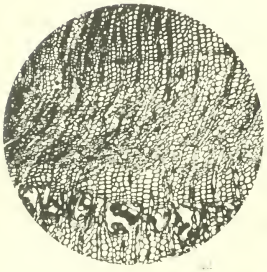
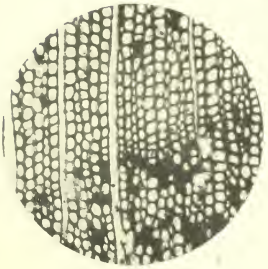
TORREY ON FOSSIL CONIFERS.

HELIOTYPE CO., BOSTON.







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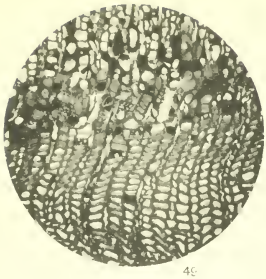

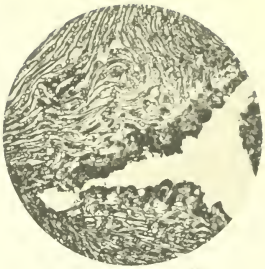

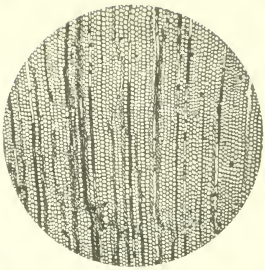

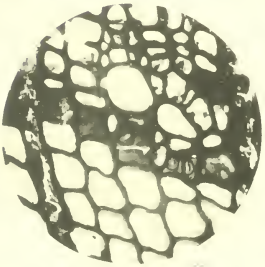

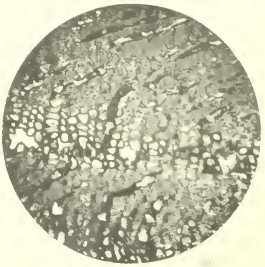

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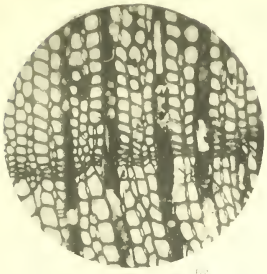

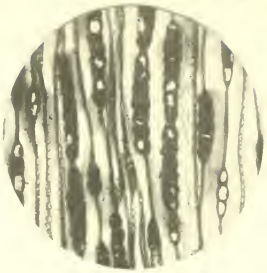

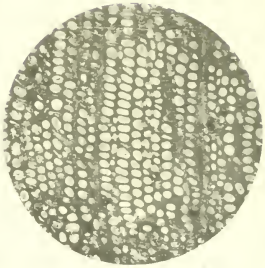

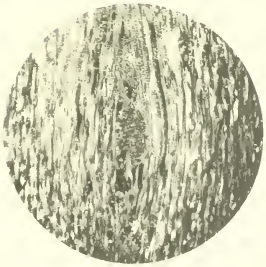

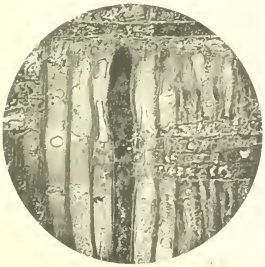

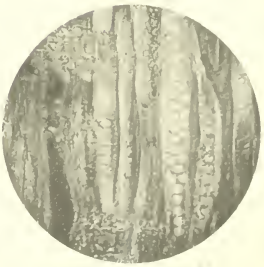

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PLATE 16.

The "Sarja," steamship of the Russian Polar Expedition, in winter-quarters during the first winter, on the western coast of the Taimyr peninsula.

PLESKE ON BIRDS OF THE TUNDRA.

PUBLISHED WITH INCOME FROM
THE BEQUEST OF
WILLIAM BREWSTER.

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PREFACE.

My beloved and honored colleagues of the Zoölogical Museum of the Russian Academy of Sciences, the late V. Bianchi and A. Bialynicki-Birula (the latter a member of the Russian Polar Expedition (1900–1903) under the late Baron Edward von Toll and editor of the scientific publications of the Expedition), have suggested that I undertake the description of the ornithological material brought back by that Expedition. Before undertaking this task I made a review of (1) the rich and interesting collections made by the Expedition; (2) the classic work of Birula on the biology of arctic birds, the breeding habits of some species of which remain still quite unknown because this work, published in Russian, is inaccessible to the greater part of the scientific readers of the world; and (3) the recent literature on the ornithological fauna of the polar lands of the Old World. This study convinced me on the one hand of the very exceptional scientific value of the collections of the Russian Polar Expedition and on the other of the fact that the latest work on the arctic bird fauna, that of Schalow (Fauna der Arktis), might be supplemented by a considerable list of Russian publications and unpublished facts from the collections of our Zoölogical Museum. I decided therefore to broaden the program of my work and to give as nearly complete a review as possible of the entire ornithological fauna of the Eurasian portion of the "tundra" (arctic-alpine zone) of the holarctic region. In order to group as best the literature concerning the different parts of the region considered, I have subdivided it into twenty-one sections, which I have separately treated in Part III of this paper. These subdivisions are for the most part quite artificial and in no case represent separate zoögeographical units. This broadening of my undertaking has made it possible for me to make some deductions concerning the Eurasian arctic fauna which would have escaped me had I limited myself merely to the material of the Russian Polar Expedition. I trust therefore that the reader will not regret having in this work, instead of a description of the faunas of Western Taimyr and the New Siberian archipelago, a general survey of the ornithology of the Eurasian portion of the holarctic tundra. At the same time I must crave his indulgence for this work, carried out under very difficult conditions of living and of labor, and pardon for too many faults of omission. For I undertook this great task solely to forget my personal misfortune and an existence excessively hard, and I have too often caught myself in mistakes due to inattention or weariness. In order to eliminate these I have re-read the manuscript four times, but nevertheless I am not quite sure but that a certain number of errors remain.

During the course of the work I have become convinced that its form approached

more and more the plan of the well-known memoir of Professor J. A. Palmén of Helsingfors on the ornithological material brought back by the celebrated expedition of the "Vega." I trust that my late distinguished colleague and friend would have seen therein only a sign of high personal regard and admiration for his scientific publications. The work has greatly gained through the kind collaboration of the eminent artist, B. Watagin of Moscow, who has undertaken the execution of the colored plates.

It remains for me to express my very hearty thanks to the late V. Bianchi and A. Birula for the kind help which they have given me in the course of the undertaking. The former has placed at my disposal the ornithological bibliography which I had prepared thirty years ago for my Russian Ornithography and which he had later completed from the Zoölogical Record, and has helped me in many cases to unravel questions of systematics and modern nomenclature with which I was not sufficiently familiar because of more than a quarter-century's interruption in my ornithological labors. In the latter of my colleagues I ever found a ready willingness to furnish me with needed explanations as to the course and details of the Russian Polar Expedition in which he took so important a part. No less acknowledgment must I express to my esteemed friend and colleague, Prof. Dr. P. Sushkin, member of the Russian Academy of Sciences, for his kind and successful efforts to place this work, as well as to the eminent American naturalists, Outram Bangs and Thomas Barbour, through whom the Boston Society of Natural History has kindly agreed to undertake its publication.

Finally I have to remember: G. P. Gorbunow and A. S. Tolmacheff who have kindly placed at my disposal the unedited materials and observations, obtained by the former during the circumnavigation in 1925 of the two islands of Nova Zembla and by the latter during his expedition in 1926 to Kolguev Island; Lindholm, malacozoölogist of our Museum, who has kindly assisted me in examination of the English text of my manuscript and my correspondence in English; and B. Staegmann, Assistant of our Museum, who has rendered me many services. To all these gentlemen I am very grateful. All the dates are in "new style."

Finished, April 1921.
Reread, July 1926.

TH. PLESKE.

NOTE.—In the following pages, the accounts of species noted by the Russian Polar Expedition are numbered consecutively and are printed in larger type; those of species not secured by the Expedition are in smaller type.

In cases where the Latin names preferred by the author differ from those adopted in the American Ornithologists' Union Check-list or in the Practical Handbook of British Birds, the latter names are given in parentheses.

PART I.

A Brief Account of the Course of the Russian Polar Expedition, 1900–1903, with a List of the Localities where the Bird Fauna was studied and Collections were made.

The Russian Polar Expedition was undertaken by the Academy of Sciences of St. Petersburg, on the initiative of that experienced arctic explorer, Baron Edward von Toll, to explore that part of the Siberian Arctic Ocean north of the New Siberian archipelago where is situated the De Long group of islands (Bennett, Jeanette and Henriette) and where there was supposed to be a vast land area, Sannikoff's Land. A Norwegian whaleship, the "Harold Haarfager," was secured and equipped as the vessel of the Expedition, and renamed the "Sarja" (The Dawn). Dr. H. Walter, physician of the Expedition, skilful hunter and amateur ornithologist of very satisfactory experience, undertook the ornithological observations. In addition the Expedition included among its personnel, the zoölogist of the Zoölogical Museum of the Academy, A. Bialynicki-Birula, who was given charge of the study of mammals (his specialty at the Museum), all invertebrate animals and botany. Birula, who had previously, in 1899, taken part in the scientific expedition for the measurement of an arc of the meridian at Spitzbergen and had during this expedition acquired much experience in observing and studying the life of arctic birds, devoted his free time during the Russian Polar Expedition to ornithological investigations and helped his colleague, Dr. Walter, by securing for him much valuable material as the result of his collecting. But in addition to that, he kept a daily ornithological journal, at first brief, but later more detailed, that made it possible for him to publish in 1907 (Mém. Acad. Sci., St. Pétersbourg, cl. phys.-math., ser. 8, vol. 18, no. 2) his classic work, "Sketches of bird life on the arctic coast of Siberia" (in Russian). After the death of Dr. Walter in 1902, during the second wintering of the "Sarja" in Nerpalach Bay, Kotelny Island, Birula took entire charge of the ornithological work of the Expedition, aided by nearly all its other members, who in the course of their trips in the vicinity of the strait where they wintered, or during their independent auxiliary journeys, let no opportunity be lost to add to the completion of the ornithological collections and to record in their journals their observations on the bird life met with. In the course of the account I shall have many occasions to revert to their work and to indicate the worth of each person's observations, the specimens and the notes furnished by these valued collaborators.

The ornithological investigations of the Expedition began at noon as the vessel entered the Kara Sea. During a stay of several hours near Vaigach Island, the first ornithologi-

cal excursion was made, August 8, 1900. The same day the "Sarja" returned by way of the Jugor Strait to the Kara Sea and after a very hard passage of five days through thick ice, anchored in Dickson Bay, north of the mouth of the Yenisei River. The vessel remained there, to repair some slight damage sustained while crossing the Kara Sea, between 12 and 17 August. During this time the naturalists enjoyed the opportunity of making excursions to Kuzkin Island, situated opposite Dickson Bay (Pl. 17, fig. 2). The ship left the harbor 18 August and coasting along the west side of the Taimyr peninsula, stopped at several islands along the way, among others (25 August) an island on Minin Bay, and on 27 August reached Middendorff Bay, 75° north latitude, 92° 59′ east longitude. Here the ship was obliged to remain nearly two weeks, from 28 August till 16 September, while awaiting the opening out of the ice which had blocked both entrances to the bay. On 16 September the passage was free, and the "Sarja" succeeded in making her way about 100 kilometers farther to the northward, stopped at Kolomeitzeff Bay and at the picturesque Bay of Wolves, and finally on 26 September reached "Sarja Harbor," where she passed her first winter.

During the autumn of 1900 the Russian Polar Expedition had favorable opportunity for studying, in the localities mentioned, at the mouth of the Yenisei and in Western Taimyr, the migration of the birds which were passing in large numbers from their breeding grounds by way of the much-frequented route along the west coast of Taimyr, in part to the valleys of the Yenisei and the Ob, and in part to the westward, following the coasts of the Arctic Ocean. The members of the Expedition succeeded in establishing the occurrence of many Gulls of several species on Kuzkin Island (Dickson Bay). On the southern coast of the island were considerable companies of *Rissa rissa* (Linné) (=*tridactyla* (Linné)); on the cliffs surrounding Dickson Bay were *Larus glaucus* Fabricius (=*hyperboreus* Gunnerus); in the bay itself other Gulls were supposed to be *Larus argentatus taimyrensis* Buturlin, while on the west coast were seen two individuals of the *Pagophila eburnea* (Phipps).

The passeriform birds had not yet left Kuzkin Island and flocks of *Plectrophenax nivalis nivalis* (Linné), *Anthus cervinus* (Pallas) and *Otocorys* (=*Eremophila*) *alpestris flava* (Gmelin) were all three noted at the seashore; in the wood heaped up on the shore, two young individuals of *Saxicola* (=*Oenanthe*) *oenanthe oenanthe* (Linné) were identified, one of which was secured for the collection. Of chief interest, however, were the many species of waders that passed in flocks from their breeding grounds, as yet nearly unknown, to their winter-quarters. Considerable flocks of *Limosa lapponica lapponica* (Linné) in company with *Tringa* (=*Calidris*) *canutus* (Linné), *Calidris arenaria* (Linné) (=*Crocethia alba* (Pallas)), and *Limonites* (=*Calidris*) *minuta minuta* (Leisler) were passing Middendorff Bay between 27 August and 6 September as well as numerous flocks of

Brant Geese, *Branta bernicla bernicla* (Linné) on 29 August; but not a single example of the *Arenaria interpres* (Linné) was noted, which confirms the observations made in the years following that the Turnstone leaves the northern latitudes earlier. Somewhat later in the season, between 6 and 11 September, flocks of other shorebirds were passing Middendorff Bay, such as *Ancylochilus subarquatus* (Güldenstädt) (=*Calidris ferruginea* (Brünnich)), *Pelidna* (=*Tringa*) *alpina alpina* (Linné), and last of all, *Arquatella* (=*Calidris*) *maritima maritima* (Brünnich) and *Crymophilus fulicarius* (Linné). The last flocks of shorebirds were seen 18 September, slightly to the northward of Middendorff Bay. In the same place, as well as at Kolomeitzeff Bay and Bay of Wolves, was an occurrence of very particular interest, namely, the appearance on the tundra of a certain number of Titmice, *Parus ater ater* (Linné), inhabitants of the fir forests of the wooded region.

By the time the ship reached "Sarja Harbor," the tundra was already covered with snow and during the remainder of the year 1900 no more birds were to be seen except for some solitary examples of *Plectrophenax nivalis nivalis* (Linné) that had not yet left these latitudes, single individuals of *Pagophila eburnea* (Phipps), attracted 9 September by the carcase of a white bear that had been killed, and a few Ptarmigan, *Lagopus rupestris* (Gmelin).

The place where the Expedition passed its first winter at "Sarja Harbor" is situated in 76° 8′ north latitude and 95° 6′ east longitude and is a widening of a strait that extends along the north coast of Western Taimyr (Pl. 18, figs. 1, 2). The western portion of this strait, between Nansen Island and Jeremejeff peninsula, is called Fram Strait, and this presently broadens out into "Sarja Harbor," and opens into the Taimyr Strait, discovered by the "Vega" Expedition, by two passages,—the western bearing the name of Sverdrup, the eastern that of Palander,—which encircle the small Bonnevie Isle.

At "Sarja Harbor" the Russian Polar Expedition remained from 26 September 1900 till 24 August 1901, that is, during the winter of 1900–01 and the summer of 1901. According to Birula the northwest and north coasts of Western Taimyr attain but a slight elevation and very rarely (notably on promontories separated by bays of gently sloping borders) does the height of the shore reach more than 30 to 40 meters above sea level. Inland the terrain rises gradually and appears as hills with rounded summits and gentle slopes which sometimes form chains of hillocks. On the Western Taimyr coasts there are but two such ranges to which the name of mountains might be applied. One of these is on the south coast of Middendorff Bay and is called Baer Mountains and the other, more considerable, extends from the northeast corner of the peninsula to Walter Bay. It maintains throughout the form of hills with rounded summits, reaches a height of 300 meters and bears the name of Tschernaja Gora (Black Mountain).

From the 75th degree of north latitude the prevailing rock in Western Taimyr is represented by beds of gneiss or gneissic granite and the metamorphosed schists appear only in its eastern part. The round-topped hills consist of gneiss as do the promontories of the coasts and the islands adjacent. On account of these formations the Taimyr coasts abound in bays of very different dimensions and have the character of fiords. The lack of high and precipitous cliffs along the coasts of Taimyr results in the complete absence in these latitudes of rocks (*bazary*) where Gulls, Guillemots and Fulmars might nest. Birula has made out likewise that in all the parts of Western Taimyr the sea has receded along the coasts; thus at Nansen Island he found beds containing mollusks of post-Tertiary species at a height of 34 meters above sea level. Moreover, the coasts abound in lagoons, sometimes connected with the sea by water-courses or again, entirely separated from it by barriers of sand or pebbles. The former renew their water with the flood tide and as a result are more or less saline; while the latter are perfectly fresh and in summer have an abundant fresh-water fauna and flora. These lagoons and lakes are favorite resorts for sundry species of anatine birds during their time of moult.

The beds of gneiss appear at the surface not only at the borders of the sea but also in all the more elevated parts of the tundra, on the slopes and summits of the round-topped hills. The low parts of the tundra, covered with dwarfed vegetation, are sometimes muddy or sometimes enclose small pools of water; they are of a brownish tint, while parts of the gentle slopes of the hills covered with broken fragments of gneiss appear as black spots and impart to the summits of these hills, covered with débris along their entire length, a black aspect. In summer these layers of broken gneiss are covered with many-colored lichens and Cladonia moss and afford nesting places for many *Plectrophenax nivalis nivalis* (Linné) and *Lagopus rupestris* (Gmelin). The tundra of the Taimyr is also strewn with a considerable quantity of rounded bowlders, occasionally of huge dimensions; these rocks also occur frequently in the pools of water and here they serve as nesting places for Gulls.

The western portions of the north coast of Western Taimyr differ radically in their geological structure from the regions situated on the other side of the southern shores of the Bay of Taimyr to the east of Walter Bay. In the former the gneisses and granites through efflorescence produce the cold and often frozen clay which favors the formation of pools of icy water, while the beds of metamorphosed schists, which form the latter, are much drier and by disintegration form a coarser and better-drained soil. These differences in the quality of the soil have obviously a certain influence on the composition of the flora of these two parts of the Taimyr coasts.

In 1900, according to Birula's journal, in Middendorff Bay, the first snow fell 30 August and at the same time the air temperature fell below 0° Centigrade; on 21 September the

tundra about Kolomeitzeff Bay was covered with snow. In the spring of 1901 the temperature remained above 0° C. all day on 9 and 10 June, which means the beginning of melting. The tundra is thus completely snow-covered during the interval of about eight months and twenty days, so that organic life in these latitudes is active for only about one hundred days a year. A portion of this short season is expended, however, in the melting of the abundant snow; from the beginning of warm nights the tundra becomes covered with many rills and water-courses, which carry the water from the melting into the neighboring sea. The lower places become covered with water, making a multitude of ponds of very different shapes and sizes. In addition there is in Western Taimyr a certain number of more or less considerable rivers, one of which reaches the sea to the south of Middendorff Bay, and one, the Kolomeitzeff River, empties into Walter Bay.

All the Western Taimyr is situated so far north of the forest limit, that it is quite without even shrubs. It is only along the larger rivers that one may find on the sandy banks not only a rather abundant herbaceous flora but also two or three species of willows in habit like stunted shrubs, for the most part prostrate on the ground. These willow shrubs do not anywhere form more or less dense thickets but are scattered over the tundra here and there, like herbs growing on a hard soil that do not cover the ground but grow in separate clumps, between which the soil is covered only by moss and lichens. This flora rarely grows to a greater height than 9 to 13.5 centimeters and in the driest places is composed of two or three species of *Saxifraga* (among which *Saxifraga caespitosa* predominates), *Potentilla fragiformis*, *Papaver nudicaule* and *Luzula hyperborea*, and some grasses; it is only the beautiful *Siewersia glacialis* that forms higher and more dense clusters but this species becomes rather rare on the north coast of Taimyr. The intervals between the clumps of the plants just mentioned are carpeted with moss and lichens of the genera *Peltigera*, *Cladonia*, *Tamnolia* and *Dufourea*.

According to Wahlenberg's classical division of the alpine zone, the higher part, *Regio alpina* α *glacialis*, characterized by glaciers and permanent snow-fields, is not represented in Western Taimyr. The beds of gneiss on the shores of the Polar Sea and especially those on the summits of the hills, are covered only with moss and lichens and may be referred to the second division of the alpine region, the *Regio alpina* β. *camporum nudorum*. Finally the portions covered with herbs and dwarf willows belong to the *Regio alpina* γ. *salicum*. Its litter of fragments from the beds of gneiss serves chiefly as the nesting places for *Plectrophenax nivalis nivalis* (Linné) and the Rock Ptarmigans, *Lagopus rupestris* (Gmelin), while in the portions of the tundra covered with arctic plants nest not only an abundance of *Plectrophenax* but also *Calcarius lapponicus lapponicus* (Linné) and particularly a number of shorebirds such as *Tringa* (= *Calidris*) *canutus* Linné, *Ancylochilus subarquatus* (Güldenstädt) (= *Calidris ferruginea* (Brünnich))

and *Calidris arenaria* Linné (=*Crocethia alba* (Pallas)) whose eggs and downy young were at the time of the Polar Expedition rare in collections and their nesting habits almost unknown.

In 1901, two members of the Expedition, Birula and the late Dr. Walter, observed the arrival of migratory birds on their nesting grounds. They succeeded in gathering important material, as of nests and eggs, and in obtaining downy young of nearly all the rare species of shorebirds mentioned above. In addition, Birula kept his daily notebook with such scrupulous exactness that he was able to rely upon it for his work published in 1907 on the habits of arctic birds in general and particularly on the behavior, hitherto unknown, of rare shorebirds during the time of their breeding and sojourn in high latitudes and in so complete and vivid a manner that the intimate lives of these birds may be considered better studied and described than the habits of many common species.

I should add that Walter and Birula made several excursions into the more distant vicinity of the vessel's first winter-quarters for the purpose of studying the difference in physicogeographical and biological conditions in other parts of Taimyr.

The ornithologists of the Expedition were unable in 1901 to observe the autumnal migration of birds for the "Sarja" left its anchorage 25 August, that is, at the beginning of the migration when the greater part of the birds of passage were gathering in flocks and in anticipation of the journey, and the Turnstone (*Arenaria interpres* (Linné)) was the only species that had already left these latitudes.

After leaving the place of her first winter sojourn, the "Sarja" on 1 September 1901, doubled Cape Cheljuskin and held her course through the Nordenskiöld Sea at some distance from the coasts of Eastern Taimyr. Before reaching the latitude of Chatanga Bay, the ship changed her course and bore to the eastward between the 75th and 76th parallels toward the archipelago of New Siberia. During this traverse, effected between 5 and 11 September 1901, the ornithologists had an opportunity to observe in the open sea Guillemots, *Uria lomvia arra* (Pallas) and *Cepphus mandti* (Lichtenstein), which came probably from the gull cliffs on Preobraschenie Island, as well as flocks of *Crymophilus fulicarius* (Linné) which were moving southward. After covering about half the distance between Taimyr and the New Siberian archipelago, the "Sarja" changed her course to the northward in search of the unknown Sannikoff Land but on account of the ice was unable to proceed beyond 77° 9′ north latitude. In sight of Bennett Island of the De Long archipelago, the "Sarja" for three days vainly endeavored to reach the island which was completely encircled by compact ice for a distance of about 25 kilometers. The Expedition had therefore to return to the place of its second winter anchorage at Kotelny Island in the New Siberian archipelago but, before going permanently into winter-quarters, made once more an attempt to force a passage to the northward, reaching

77° 32′ north latitude, but found there an impassable barrier of ice. Although the bird life of Bennett Island could not be studied, the ornithologists determined the presence in these latitudes of a large number of birds of the genera *Uria*, *Cepphus*, *Rissa* and *Harelda*, as well as King Eiders, *Erionetta* (=*Somateria*) *spectabilis* (Linné), and Rosy Gulls, *Rhodostethia rosea* (Macgillivray).

The quarters for the second wintering of the "Sarja" were chosen on Nerpalach Bay, in the western part of Kotelny Island, at 75° 22′ north latitude and 137° 16′ east longitude, opposite the southern point of Bielkovski Island. The "Sarja" anchored in Nerpalach Bay 24 September 1901 at a part of the season when most of the birds had already left the latitudes of the New Siberian archipelago and the Expedition found none in any abundance except Gulls and Willow Grouse.

At the winter-quarters of the second year the Expedition was met by the geologist, C. Wollosowicz, who, accompanied by M. Brusneff and O. Cionglinski, had charge of the auxiliary expedition during the summer of 1901, with the purpose of organizing a series of depots on the different islands of the New Siberian archipelago that should facilitate the return of the main expedition in case the ship should be lost to the northward of the archipelago. During this auxiliary expedition, Cionglinski undertook to make ornithological investigations and succeeded in bringing together a rather considerable collection of birds from Great and Little Ljakoff, Kotelny and Faddejefski Islands, among these some very rare species not afterward found in the archipelago by members of the main expedition.

During the second wintering of the "Sarja," the Expedition suffered the sad loss of its ornithologist, Dr. H. Walter, who died at Nerpalach from articular rheumatism. As a result of this unhappy event, the observations on the arrival of migratory birds at Kotelny Island in 1902 were very incomplete, for by the time that Birula had left for the Island of New Siberia, 11 May, many of the birds of passage, particularly the shorebirds, had not yet come. Dr. Katin-Jartzeff, who replaced Dr. Walter as physician, undertook also ornithological observations. In 1902 he collected diligently in the vicinity of Nerpalach and kept a journal of his observations. He was successful in securing very valuable notes and specimens, including some very interesting notes on breeding habits of the Snowy Owl, *Nyctea nyctea* (Linné).

Early in 1902 Birula was given the task of making a geographical and biological exploration of the Island of New Siberia. The trip from Kotelny to the western coast of this island consumed fifteen days and Birula was enabled to study the details of waterbird migration along the south coasts of Kotelny and Faddejefski Islands. On 26 May he came in sight of the west coast of the Island of New Siberia, which appeared still as if in midwinter. The temperature, particularly at night, kept below 0° C., and it was

only in a few of the more sunny spots that life began to manifest itself in the appearance of some green plants and certain species of invertebrates as *Poduridae* and black spiders. Birds were still entirely absent. Birula devoted the next fortnight to a study of the arrival of migrants on the west coast of the island and, between 11 and 15 June, made a short excursion toward Wosnesenija Bay (Ascension Bay), remaining another week on the western coast and then undertaking on 22 June a journey of more than a month to explore the northern and eastern coasts of the island. From 31 July till his final departure from the island 4 December, Birula, with the exception of a brief visit to the basin of the Bolschaja River, was obliged to remain on the western coast of the island, where the "Sarja" was to come to find him. Throughout his stay on the Island of New Siberia, he made many observations on the birds and succeeded in making a thorough study of the unknown or little-known habits of a considerable number of Arctic species, especially *Tringa* (=*Calidris*) *canutus* Linné and *Calidris arenaria* (Linné) (=*Crocethia alba* (Pallas)).

The archipelago of New Siberia, as shown by its geological structure, is but a continuation of the Siberian mainland. It is situated between 73° 8′ and 76° 15′ north latitude and 136° 30′ and 151° east longitude and the island nearest the continent of Asia is only separated from it by Lapteff Strait, which is 70 kilometers wide. The archipelago is divisible into three groups: the isles Great and Little Ljakoff, called the Near Islands; the isles Stolbowoi, Wassiljefski and Semenowski, bearing the name of the Little Islands; and the isles Kotelny, Bielkovski, Faddejefski, New Siberia, Strichow, Figurin, and Shelesnikow, which in scientific works are designated as the Anjou group of islands and by the indigenous population are called the Far Distant Islands.

The sea surrounding the archipelago is considerably affected by the large rivers, such as the Lena, the Yana and the Indigirka, that empty into the Arctic Ocean at these latitudes. This influence is shown in the less saline nature of the superficial strata of sea water, in the accumulation of considerable quantities of driftwood on the shores, and especially in the presence of very extensive open waters throughout the winter in the region of the archipelago. The former investigations of Hedenström and especially of Naval Lieutenant Anjou have shown that the areas of the Arctic Ocean surrounding the archipelago of New Siberia on the west, north, and east are either free of ice to a considerable extent or are covered with thin, weakened and floating ice. Brusneff confirmed this same fact in 1903, and found the sea open in the month of March for a distance of 25 kilometers from the Island of New Siberia. Birula expressed the opinion that the limit of the ice fields along the coasts of Siberia extends probably from Eastern Taimyr, including the mouths of the Anabara, the Olenek and the Lena, northward along the western shores of the New Siberian archipelago, which it includes, and thence

passes southward toward the Siberian mainland. This is explained, according to the same authority, by the constant movements of the ice during the entire winter, from the Siberian coasts in the direction of the northern and northeastern shores of Greenland and toward the entrance to the Atlantic Ocean. This movement must obviously force the ice that borders the Siberian mainland constantly to become in part detached and so to form during the entire winter areas clear of ice. The presence of these openings results in the coming of flocks of King Eiders, *Erionetta* (= *Somateria*) *spectabilis* (Linné) in the latitude of the New Siberian archipelago some fifty days earlier than in Western Taimyr. During this passage a considerable number of Eiders succumb to the fatigue of the crossing, in which the birds must traverse enormous expanses of bare ice, with the temperature 10° to 15° below 0° C. by day and much lower still by night. At the approach of the breeding season the Eiders make their way back to the mainland in part; at least Birula in the spring of 1902 established that their migrations were not only to the northward but after that to the southward as well.

Geologically the islands of the New Siberian archipelago are nothing more than the remains of strata washed from the mainland. For the most part they are covered with clayey soil, muddy and saturated with icy water, and containing in addition beds of pure ice. It is only the western coasts of the islands Kotelny, Bielkovski (Pl. 19, fig. 1) and the little island Strisheff (Pl. 19, fig. 2) that are formed of eroded remnants of the Silurian and Devonian sandstones. At Kotelny Island these are cut by the mouths of several rivers and intersected by two bays, Durnovskaja Bay and Nerpalach Bay. Along the seacoasts these eroded remnants of solid rock serve as nesting places for seabirds and it is only in these places that the islands of the New Siberian archipelago afford *bazary* (gull rocks). Elsewhere in the archipelago such erosion remnants of rock are very rare and only appear in the shape of some elevations in Great Ljakoff Island (Emij-tas, Kowrischka-tas, Kaptalai-tas, and the Keheljach peninsula), Kotelny Island (Wolokitin Mountains—Malakatyn-tas—with a height of 1500 feet above sea level) and the Derevjannija Gory of the Island of New Siberia. When the snow melts, the areas covered with muddy strata of clay are heavily eroded by streams of water and become transformed along their slopes, first into pyramids of a height varying from one-half to six and a half meters, then into cones of differing aspect, which finally undergo complete dissolution. These hills, covered with a very meager flora, are called *baidsharaki* (see Pl. 20, figs. 1, 2; Pl. 21, fig. 1). The oldest of them, bearing the thickest and most abundant plant growth, are frequented in winter by the Willow Grouse that find there on the areas bare of snow a more abundant supply of food and hide in the snowdrifts heaped between the hills. Further, the tops of the *baidsharaki* serve as nesting sites and observation posts for the Snowy Owls, *Nyctea nyctea* (Linné). The scarcity of round rocks,

fragments of gneiss or granite, in the tundra of the islands of the New Siberian archipelago forces *Plectrophenax nivalis nivalis* (Linné) to nest only on the precipitous slopes of the seacoast, while in the other parts of the islands *Calcarius lapponicus* (Linné) predominates. I should again mention the islet Koptoloch-ary (Isle of Gulls), situated off Kotelny Island opposite the mouth of the Balyktach, its largest river. This little islet is the nesting place of great numbers of Gulls, Brant Geese and Eiders. Finally in the mouths of the rivers and on the lakes (Pl. 22, fig. 1), large companies of Geese gather during the moulting period.

The vain attempts of the "Sarja" in 1901 to locate Sannikoff Land and to land at Bennett Island decided Baron Toll to attempt to reach the latter in canoes (*baidarki*). He left Nerpalach Bay 7 June 1902, accompanied by the astronomer Th. Seeberg and two natives, and made his way back along the north coasts of Kotelny and Faddejefski Islands to Cape Wysoki on the Island of New Siberia. He succeeded in reaching Cape Emma on Bennett Island 3 July, and after waiting in vain for the arrival of the "Sarja," which was to have come in search of him, he decided at first to winter on Bennett Island and built a hut there of driftwood, but later changed his plans and on 8 November 1902 he with his companions left the island in order to return to the New Siberian archipelago. On account of the lateness of the season, the severe weather and the dangerous condition of the ice the explorers were unsuccessful in their attempt and succumbed to the hardships of the passage.

On 21 August 1902 the "Sarja" left Nerpalach Bay and for ten days attempted in vain to reach Bennett Island and to accomplish the alloted task of bringing back Baron Toll and his companions from that island and Birula from the Island of New Siberia. The commander of the "Sarja," Naval Lieutenant Th. Matiessen decided 1 September to abandon his attempts at rescuing the members of the Expedition and made his way back to the mouth of the Lena where he anchored 8 September in Tiksi Bay, and there he dismantled the "Sarja." While this work was in progress, Matiessen also made some ornithological observations and collected a certain number of birds.

During the summer of 1902, M. Brusneff undertook a careful study of the bird life of the Charaulach Mountains on the Siberian mainland, in the latitudes of the mouth of the Lena. His rather large and varied collections include a series of species not met with by the Expedition either in Taimyr or in the New Siberian archipelago and complete the material brought back by the Russian Polar Expedition.

It only remains for me to mention that Birula, having given up all hopes of being rescued by the "Sarja," devoted his energies during the end of August, the month of September and a part of October, to hunting reindeer for the sole purpose of securing provision for his part of the Expedition and the dogs, sufficient to enable them to make

the passage to the mainland. Having awaited until the ice had become solid enough, he left the Island of New Siberia 4 December 1902 and returned by way of the islands Faddejefski and Great Ljakoff to the Swjatoi Nos headland and after a journey of extreme hardship succeeded, after twenty-five days, in reaching the town of Kasachje on the Yana.

When, in the autumn of 1902, a telegram from the commander of the "Sarja," Naval Lieutenant Th. Matiessen, brought the news that the ship had not succeeded either in reaching the part of the Expedition under the leadership of Baron Toll in the latitudes of Bennett Island, or in picking up Birula and his companions from the Island of New Siberia, grave fears arose as to the fate of these members of the Expedition. So the Government decided to send out in 1903, two expeditions, one to Bennett Island and the other along the northern coasts of the different islands of the New Siberian archipelago. To Naval Lieutenant A. Kolchak was given the task of attempting to reach Bennett Island and of there making search for Baron Toll, while the carrying out of the latter project was intrusted to M. Brusneff. Birula's safe return to the mainland in December 1902, resulted in a change of the relief expedition's plans in that they now had but to go to the help of Baron Toll's party. A vain search was made by Brusneff for traces of Baron Toll and his men on the north coasts of Kotelny, Faddejefski and New Siberia Islands, during the course of which he himself undertook ornithological observations on the northern shores of Kotelny and New Siberia Islands, while Quartermaster Tolstow did the same on Faddejefski Island while he was there. After failing to find any trace of the lost explorers this part of the relief expedition returned to the mainland. Meanwhile Kolchak succeeded after strenuous efforts in transporting a ship's boat to Cape Wysoki of New Siberia Island. In this he set out with six seamen on 15 August 1903 and two days later in a relatively open sea he reached Cape Emma of Bennett Island. Here on the spot where Baron Toll's party had camped he found evidence that unhappily left no doubt as to the loss of Baron Toll, the chief of the Expedition, of Seeberg, the astronomer, and the two natives. There was nothing more that Kolchak could do beyond preserving for science the journals of the late Baron, the map of Bennett Island prepared by Seeberg and in addition a part of the geological collections. During this final expedition Kolchak was active in ornithological research and kept a daily notebook concerning the birds observed. Among the documents recovered at Bennett Island was a list of birds that the late Baron Toll had been able to identify on that island.

PART II.

Material and Observations.

PASSERIFORMES.

Corvidae.

1. Corvus corax corax Linné.

Corvus corax Linné. Birula, Mém. Acad. Sci. St. Pétersbourg, cl. phys.-math., ser. 8, vol. 18, no. 3, p. 138, 1907 (in Russian).

Local names: called by the Russian population everywhere *woron;* in Yakut, *ssvor* (at the mouth of the Lena, Bunge) or *svor;* in Tunguse, *oljyndja* (Birula); in Chuckche, *uedlje* (Palmén).

As to the islands and archipelagoes adjacent to the Eurasian coasts of the Arctic Ocean, we have the following notes on the Raven. From Spitzbergen (Sect. I) it has been recorded but once, a fact that has decided Professor König (Avifauna Spitzb., p. 142, 1911) to strike it from his list of the birds of that archipelago. For my part I regard the Raven as a bird so characteristic, so familiar to every race of men that the possibility of a mistake in its identification seems quite out of the question, and I have not the slightest hesitancy in restoring it to a place in the list of birds found in Spitzbergen. As to Nova Zembla (Sect. VIII) we have likewise but the single record of Kriwoscheja (Nature and Hunting, 1884, pt. 11, pp. 34, 53, in Russian) of one instance of the bird's presence. On Bear Island (Sect. II), the Franz Josef archipelago (Sect. IX) and the islands Kolguev (Sect. V) and Vaigach (Sect. VII) the Raven has not been noted.

The littoral of the Murman coast (Sect. III) is inhabited, especially in its western parts that include the Varanger Fjord, by an abundance of Ravens that is probably not equalled elsewhere in the entire world. Thanks to the bird's parasitic instincts and its faculty of adapting itself easily to very different conditions of life, the Raven in the Kola peninsula lives not only in the forest zone (*Regio sylvatica*) but also on the littoral of the Arctic Ocean.

In Lapland it nests sometimes in the highest trees of the wooded zone, sometimes on the cliffs of the shore in company with Gulls and Guillemots. Undoubtedly the littoral of the Arctic Ocean attracts the Raven by the abundance of food that it affords. This comes particularly from the factories for the utilization of whale carcases that are frequented by immense numbers of these birds. Next in importance is the waste from the fishery industries scattered along the entire length of the Murman coast; then the very great quantity of marine invertebrates thrown up by the tide and after storms. Finally the innumerable eggs and chicks of Gulls and Guillemots on the *bazary* (gull rocks) serve to vary and facilitate his fare.

The Raven has been observed in small numbers all along the coast of the Arctic Ocean. In the mouth of the White Sea (between Sect. III and IV) N. Smirnow (Compt. Rend. Acad. Sci. U. R. S. S., 1926, p. 32) regularly observed Ravens in spring of 1924–25 feeding on the bodies of seals abandoned by the hunters. It was noted in the Kanin peninsula (Sect. IV), in the latitudes of the mouth of the Pechora (Sect. VI), and at the mouths of the Rivers Ob (Sect. X), Yenisei (Sect. XI), and Lena (Sect. XIV) as far as 72° north latitude. One of the members of the Russian Polar Expedition, Naval Lieutenant A. Kolchak (*in litt.*) noted it 28 April on the shore of Borchaja Bay to the eastward of the mouth of the Lena. Farther to the east it has been observed at the mouths of the rivers Yana (Sect. XV), Indigirka (Sect. XVIII) and Kolyma (Sect. XIX); on the islands Great Ljakoff (Sect. XVI), Wrangel and Herald (Sect. XX) and along the north coast of the Chuckche peninsula (Sect. XXI). During the fateful cruise of the ship "Jeannette," a Raven was seen in 72° 36′ north latitude and 178° 08′ east longitude to the north of Herald Island on 30 November 1879, and two others 9 and 21 April 1880, respectively, near Wrangel Island (DeLong, Voy. Jeannette, pp. 187, 314, 328, 1883). A Raven (male) was killed on the latter island by the crew of the transport "Taimyr" 17 September 1911. It was preserved by the ship's surgeon, Dr. L. Starokadomski and sent to our Zoölogical Museum. On the basis of this specimen I have inferred that the most eastern parts of the Siberian coasts of the Arctic Ocean are inhabited by the typical race, *Corvus corax corax* Linné, with the wing formula: primaries 4, 3, 5, 2, 7, 1, 8, 9, 10; and not by the form of Bering Island, *Corvus corax behringianus* Stejneger. In the diary of Lorne Knight (Snyder, L., Univ. of Toronto Studies, biol. ser., p. 19, 1926) reference is made to having seen the Raven (*Corvus corax principalis* Ridgway) on Wrangel Island (Sect. XX) for the first time on December 1, 1921.

I presume that the Raven frequents the Siberian coasts of the Arctic Ocean only in those parts where the forest zone comes very close to the seashore and that it is rare there because of the scarcity on most of these coasts of rocks with breeding colonies of Gulls and Guillemots. Its visits, which seem fairly constant and regular to Wrangel and Herald Islands, may, I believe, be easily explained by the occurrence of such rocks peopled by innumerable Guillemots.

Corone (=Corvus) cornix cornix (Linné).—The Hooded Crow in no wise belongs to the fauna of the Eurasian tundra, and only appears there quite accidentally. It has twice been noted at Spitzbergen (Sect. I) (Exped. Nathorst, Kolthoff, Kongl. Svensk. Vet. Akad. Handl., vol. 36, no. 9, p. 96, 1903, and Dr. Bunge, in Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 308, 1902); twice on Bear Island (Sect. II) (observation of M. Tobiesen, Fries and Nystrom, Svenska Pol. Exp. Ar 1868, p. 40, 1869); then it has appeared near human habitations in the barren portions of the Kola peninsula (Sect. III) (observation of Goebel and Smirnow, Ornith. Jahrb., vol. 13, p. 45, 1902) and has twice been observed, in the summer of 1899 and in May 1900, in the Samoyede colony Malijy Karmakuly of Nova Zembla (Sect. VIII) (Zitkow and Buturlin, In the North of Russia, p. 169, 1901, in Russian).

2. **Corone (=Corvus) corone levaillanti** (Lesson).

Corvus corone Linné. Birula, Mém. Acad. Sci. St. Pétersbourg, phys.-math. cl., ser. 8, vol. 18, no. 2, p. 138, 1907.

Local name: in Yakut, *turách* (Birula).

Birula (*l. c.*) states that examples of the Black Carrion Crow were observed in 1898 and 1899 on Great Ljakoff Island (Sect. XVI). According to Buturlin (Ibis, 1906, p. 132) this bird inhabits the region about the mouth of the Kolyma (Sect. XIX) and on 31 May 1879, Harpooner Johnsen and his mate Boström saw an individual of this species near the winter-quarters of the "Vega" on the northern coast of the Chukche peninsula (Sect. XXI) (Palmén, Sib. Ish. Fogelf., p. 290, 1887) and Koren observed a Carrion Crow at Chaun Bay 6 August 1912 that Thayer and Bangs (Proc. New England Zoöl. Club, vol. 5, p. 47, 1914) have recorded as *Corvus corone orientalis* Eversmann. In all these cases it is obvious that only the eastern form of the Black Crow is the one concerned.

Trypanocorax (=Corvus) frugilegus frugilegus (Linné).—Dr. A. Bunge observed at Spitzbergen (Sect. I) on the same day that he saw the Hooded Crow, and again on the following day, a dark-colored Crow which he supposed to be a Carrion Crow, *Corone corone corone* (Linné). V. Bianchi (Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 309, 1902) has rightly corrected this observation in so far as the bird seen by Dr. Bunge must in all likelihood have been a Rook. As an accidental visitor this bird was seen by Smirnow and Goebel (Ornith. Jahrb., vol. 13, p. 47, 1902) in the northern part of the Kola peninsula (Sect. III) and the expedition for the scientific investigation of the fisheries of the Murman coast procured for our Zoölogical Museum an adult male killed 20 March 1901, in the Bay of Kola (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 263, 1902). Finally, the collection of Mr. B. Kapustin contains two Rooks: a male killed 8 April 1920, and a second taken 16 April 1921, near Yokanga on the Murman coast. In 1924 the Rook was reported from Nova Zembla (Sect. VIII, communication of Mr. A. Tolmacheff).

Sturnidae.

Sturnus vulgaris intermedius Prazak.—A female of this form of the Starling was killed by Mr. B. Kapustin, 11 May 1921, near Yokanga on the Murman coast.

Sturnus vulgaris subsp.?—Prof. A. König (Avifauna Spitzb., p. 142, 1911) found on 14 July 1907, on the north coast of Bear Island (Sect. II) some feathers and the wings of a Starling, and has identified it as of the typical form, *Sturnus vulgaris* Linné. In this case he is doubtless quite right that the remains do not represent the Starling of the Faroe Islands (*Sturnus vulgaris faroeensis* Feilden) but the question is still unsettled as to whether the specimen found might have been of the typical form *Sturnus vulgaris vulgaris* Linné, or whether it were the eastern form *Sturnus vulgaris intermedius* Prazak =*Sturnus vulgaris sophiae* Bianchi. Professor König explains his supposition on the ground that the bird whose remains he found on Bear Island, had reached there from the Norwegian coast. For my part I think it might quite as well have reached the island from England, and since there is no longer any doubt that the majority of Starlings of northern Russia, all of which belong to the form *Sturnus vulgaris intermedius* Prazak, migrate to England for the winter, an individual of this race might have strayed to Bear Island. The subspecific identity of this individual remains therefore, in my judgment, still not sufficiently determined.

Fringillidae.

Aegiothus (=Acanthis) hornemanni hornemanni (Holboell).—In the summer of 1873 a small flock of Redpolls was seen by Mr. A. Eaton (Zoölogist, ser. 2, vol. 9, p. 3806, 1874) in Widje Bay, Spitzbergen

(Sect. I) and one of the birds was shot. The identification of the specimen as the Greenland Redpoll (*Aegiothus hornemanni* (Holboell)) was made by Professor A. Newton (Yarrell, Brit. Birds, ed. 4, vol. 2, p. 144, 1882).

3. **Aegiothus** (=**Acanthis**) **hornemanni exilipes** (Coues).

List of Specimens from the Russian Polar Expedition.

Skins: male, 23 July 1902, edge of the forest in the valley of the Engalatan River, tributary of the Charaulach, mouth of the Lena (M. Brusneff); female, 24 July 1902, valley of the Charaulach River, mouth of the Lena (M. Brusneff).

Local names: in Yakut, *küstädshi* (Bunge); in Chukche, *kedliptschekadlin* (Palmén).

I am quite convinced that the two forms of Redpolls regularly occurring in the arctic portions of the Eurasian continent, namely, *A. linaria linaria* (Linné) and *A. hornemanni exilipes* (Coues) occupy two different local habitats. The typical form lives in the subalpine region and places its nest in bushes and trees at a certain distance from the ground. This form frequents the tundra (lower zone of the alpine region—*Regio alpina* γ *salicum*) only at the non-breeding season and very seldom nests there, but is confined to the subalpine region in the breeding season. *Aegiothus hornemanni exilipes* (Coues), on the other hand, appears to be an inhabitant of the *Regio alpina* γ *salicum*. It occurs in this zone farther to the north of the Eurasian continent and apparently places its nest directly on the ground because of the lack of bushes or trees in the zone it occupies. In every case where I have been able to verify the identifications of authors from specimens, it has been without exception this latter form, and in the few instances where I have not had access to the collections I assume that the identification has not been sufficiently proved. I trust that my readers will agree with me in my view of the matter after a consideration of the following observations.

Pearson (Beyond Petchora Eastw., p. 6, 1899) was the first to express his astonishment at not finding any sign of the typical form of Redpoll in Russian Lapland (Sect. III). In the vicinity of the village Yokanskoje he found in the course of a single day (20 June 1895) no less than eleven nests of *Aegiothus hornemanni exilipes* (Coues), five of which contained heavily incubated eggs and the remaining six nestlings. A Redpoll captured in 1898 by Knipowich at Katherine Bay of the Gulf of Kola has likewise been shown to belong to the pale form (specimen in the Museum of our Academy of Sciences). Although the material from the Murman coast included in the Kapustin collection embraces many Redpolls (39 specimens of *Aegiothus hornemanni exilipes* (Coues), fifteen of *Aegiothus linaria linaria* (Linné), one hybrid with beak intermediate in size (larger than in the pale form and with the rosy tint of the breast paler), yet these are insufficient to clear up completely the points at issue. Unfortunately the nests are not accompanied by the parent birds, except for a single female, so that they cannot be used in making the desired deductions. It is merely evident from this beautiful

collection that *Aegiothus hornemanni exilipes* (Coues) considerably predominates over *Aegiothus linaria linaria* (Linné) in these latitudes. In the Kanin peninsula (Sect. IV) and Vaigach Island (Sect. VII) Redpolls have been noted but the form to which they belong has not been certainly made out. On Kolguev Island (Sect. V) Pearson (Beyond Petchora Eastw., app. G, p. 312, 1899) killed a specimen of the typical form 6 July 1895. The expedition under Professor C. Derjugin took a young bird of the year of the pale form 14 August 1924 in Nova Zembla (Sect. VIII), hatched probably on some part of the mainland or on one of the neighboring islands situated to the south, whence it had wandered into higher latitudes. A pair was taken by Mr. Gorbunow 13 August 1924 on Northern Island, opposite the Schumiha River in the latitudes of Matochkin-shar. For the lower course of the Pechora (Sect. VI) Seebohm (Ibis, 1876, p. 116) records both forms, but fails to consider, either here or at the mouth of the Yenisei (Sect. XI) (Ibis, 1878, p. 385), which of the two forms extends the farther north. For the Yamal peninsula and the mouth of the Ob (Sect. X) both species have been recorded: Pearson (*l. c.*) found a nest of *Aegiothus linaria linaria* (Linné), 14 July 1897, in the neighborhood of Habarova; Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 314, 1912) brought back from his journey to the Yamal peninsula only immature specimens and for this reason hesitated to identify them definitely; while the specimens in our Zoölogical Museum in the collections of Schuchow from the Schuchja River and those from the Kusnetzow Expedition (commanded by O. Backlund as chief, and J. Wardropper as naturalist) from Cholang-jogan, tributary of the Schuchja, belong to the form *Aegiothus hornemanni exilipes* (Coues), while the specimens of the typical form collected by Schuchow, come from Beresow, situated on the banks of the Ob much farther to the south. At the mouth of the Yenisei (Sect. XI) Seebohm found both species as far as Golchiha (under 71° 30′ north latitude), the most northerly point that he reached, and was unable to determine the northern limit of distribution for each of the species. The two specimens of *Aegiothus hornemanni exilipes* (Coues) obtained by Brusneff of the Russian Polar Expedition came from the Lena district (Sect. XIV) in the Charaulach River system. The Redpolls taken by Dr. A. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 110, 1887) at the mouth of the Yana (Sect. XV) all belong to the pale form (specimens in the Museum); while the form of Redpoll found in the Indigirka River system (Sect. XVIII) is not definitely ascertained. Finally, Buturlin for the mouth of the Kolyma (Sect. XX) and Palmén (Sib. Ishk. Fogelf., p. 277, 1887) for the north coast of the Chuckche peninsula (Sect. XXI) record only *Aegiothus hornemanni exilipes* (Coues).

Aegiothus (=Acanthis) linaria linaria (Linné).—Since I have just listed all the references to the Common Redpoll for the countries bordering the Eurasian tundra and have set forth my views as to the nature of the northern limit of the geographical distribution of the two forms, I will here merely refer the reader to the account of *Aegiothus hornemanni exilipes* (Coues).

Loxia curvirostra curvirostra (Linné).—A small flight of Crossbills appeared 25 July 1868 at Bear Island (Sect. II) and two specimens were taken by Malmgren (Ibis, 1869, p. 230).

Passer domesticus domesticus (Linné).—The collections made by Kapustin include three females of the common House Sparrow, captured at Yokanga, on the Murman coast (Sect. III). All these specimens were taken in early winter, one on 30 October 1921, and the two others 15 November 1923. One is therefore forced to admit that these birds had reached Yokanga along the southern branch of the Gulf Stream and were attempting to winter in the parts of the Kola peninsula influenced by that warm current. Zitkow and Buturlin (In the North of Russia, p. 169, 1901, in Russian) record that during two summers a pair of Sparrows lived in the Samoyede village of Malijy Karmakuly, Nova Zembla (Sect. VIII), and even passed one winter but appeared loath to nest there.

Passer montanus montanus (Linné).—Two examples of the Tree Sparrow appeared at Yokanga on the Murman coast (Sect. III): a male 21 May 1921 and a female 16 June 1920 (Kapustin collection). Pearson (Three Summers among the Birds of Russ. Lapl., app. 1, 1904) records this species for the Kanin peninsula (Sect. IV). Obviously these cannot be other than quite exceptional instances.

Pyrrhula pyrrhula pyrrhula (Linné).—The collection of Kapustin contains a male, 7 December 1923, and a pair, male and female, 10 October 1920, killed at Yokanga, on the Murman coast (Sect. III). The lateness of the season implies that these individuals sought those parts of the Kola peninsula that come under the influence of the Gulf Stream.

Cynchramus (=**Emberiza**) **schoeniclus polaris** (Middendorff).—An adult male of this species, evidently an accidental visitor, was killed by the crew of the transport "Vaigach" on 4 June 1915, at the winter-quarters of the Arctic Ocean Hydrographic Expedition, in Eastern Taimyr (Sect. XIII). It was preserved by Dr. Arnhold and transmitted to our Zoölogical Museum.

Junco hyemalis (Linné).—The single specimen, a female, of this species was killed 4 June 1879, by one of the members of the "Vega" Expedition near the village of Tjapka, on the north coast of the Chuckche peninsula (Sect. XXI) (Palmén, Sib. Ishk. Fogelf., p. 284, no. 14, 1887).

4. Plectrophenax nivalis nivalis (Linné).

Plectrophenax nivalis (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 338, 1901. Kolomeitzeff, *ibid.*, vol. 15, no. 5, p. 507, 1902. Walter, *ibid.*, vol. 16, no. 5, p. 232, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 196, 1902. Matiessen, *ibid.*, vol. 18, no. 3, p. 65, 1903. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1–6, 8, 10–12, 14–15, 17–18, **138**, 1907.

Plectrophanes. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 159, 1904; Die russ. Polarf. d. "Sarja," pp. 83, 87, 276, 278–279, 314, 332, 566, 568, 591, 1909.

Plectrophanes nivalis (Linné). Brusneff, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 7, p. 181, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: two males, adult (moulting), 21 August 1900, island off Western Taimyr (Dr. H. Walter); male, winter plumage, 1 September 1900, Western Taimyr (Dr. H. Walter); male, winter plumage, 6 September, 1900, Middendorff Bay, Western Taimyr (Dr. H. Walter); male, summer plumage, 23 June 1901, west shore of Taimyr Strait (Dr. H. Walter); young, 22 July 1902, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff); young, 22 July 1902, Island of New Siberia, New Siberian archipelago (A. Birula); adult male, three females, summer plumage, 10 June 1901, Camp Michailow, Kotelny Island (O. Cionglinski); male and female, adult, spring plumage, 26 April 1902, Kasatchje, Yana River system (M. Brusneff); male, adult, 10 June 1902, mouth of the Elijdep River, (M. Brusneff); young, first plumage, 13 August 1902, Bykow peninsula, mouth of the Lena River (M. Brusneff).

In spirit: three specimens, 22 July 1902, mouth of Chukotskaya River, Kotelny Island, New Siberian archipelago; 30 July 1902, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff).

Nests and eggs: five eggs, 23 June 1901, west shore of Taimyr Strait (Dr. H. Walter); one egg def., 16 July 1902, Nerpalach, Kotelny Island (Dr. V. Katin-Jartzeff); nest with five eggs, 23 June 1903, Camp Jegorow, Kotelny Island (P. Olenin); nest with seven eggs, ? date, Camp Jegorow, Kotelny Island (P. Olenin); nest with three eggs, nest with five eggs, 26 June 1903, Mt. Derewjannijy, New Siberia Island (M. Brusneff); nest with four eggs, 23 June 1903, nest with six eggs, 27 June 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow).

Local names: in Russian, *snegir* (Zitkow, Birula, *l. c.*) or *seryi snegir* (Tolstow, *in litt.*); in Samoyede, Kolguev Island, *ounoïntsa* (Trevor-Battye); Taimyr, *ngachta gudanku* (Middendorff); in Yakut, *tulluk* (Bunge, Birula, Brusneff); in Tunguse, *mergata tscheukolan*, meaning a mottled bird (Birula); in Chuckche, *ptochekadlin* (Palmén).

The Snow Bunting, as a circumpolar species, has been recorded from all the twenty-one sections into which I divide the littoral and the adjacent islands of the Eurasian Arctic Ocean. A careful study of all the specimens from the Eurasian tundra in the Zoölogical Museum of the Academy of Sciences, has quite convinced me that this region is inhabited exclusively by the typical form of *Plectrophenax nivalis* which does not attain the slightly larger dimensions of the Snow Bunting of Bering Sea and which R. Ridgway regards as worthy of subspecific distinction.

The members of the Russian Polar Expedition observed the Snow Bunting, *Plectrophenax nivalis* (Linné), at the following places: in the Strait of Yugor, July 1900 (Birula, 1907); near Vaigach Island, July 1900 (Dr. Walter, *in litt.*); at Dickson Bay and Kuzkin Island, from 5 to 18 August 1900 (Birula, 1907; Dr. Walter, *in litt.*); on the west coast of Taimyr in Middendorff Bay, from 28 August to 15 September 1900 (Toll, 1904; Birula, 1907; Dr. Walter, *in litt.*) and Kolomeitzeff Bay 20 to 21 September 1900 (Birula, 1907); in the vicinity of the "Sarja's" winter-quarters in the autumn of 1900 and during the summer of 1901 on the west coast of Taimyr Strait (Toll, 1909; Birula, 1907; Dr. Walter, 1902, *et in litt.*); at Cape Cheljuskin 1 September 1901 (Birula, 1907); on the Bykow peninsula, at the mouth of the Lena River, 13 August 1902, at the mouth of the Yana River, 26 April and 10 June 1902 (Brusneff, see list of specimens); in the New Siberian archipelago at Kotelny Island, in 1901 (O. Cionglinski) and spring and summer of 1902 (Birula, 1907; Matiessen, 1903; Dr. Katin-Jartzeff, *in litt.;* and see list of specimens); summer of 1903 (Olenin, see list of specimens); Bielkovski (Kolchak, *in litt.);* Faddejefski, 24 May 1902 (Birula, 1907), June 1903 (Tolstow, *in litt.* and see list of specimens); New Siberia, summer, 1902 (Birula, 1907, and list of specimens), summer, 1903 (Brusneff, *in litt.*, and see list of specimens); and on Bennett Island, summer 1902 (Toll, 1904, 1909; Lieut. Kolchak, 1906).

As to the different plumages of the Snow Bunting, the material brought back by the Russian Polar Expedition is of a very particular interest. First of all, the two fledglings (one still very small with a wing of 64 mm. and tail 31, taken 22 July 1902 at

Kotelny Island by Dr. V. Katin-Jartzeff, and the other much larger with a wing of 91 and tail of 61 mm., collected 23 July 1902 in New Siberia by A. Birula) show that the young bird before obtaining its autumnal plumage must change the half-downy feathers of its first (juvenal) plumage on the head, nape, back and all the lower parts including the under tail-coverts, while the remiges and rectrices, as well as the wing-coverts, become definitive feathers and are not shed until the autumn of the year following. The young bird of 13 August 1902, taken by Brusneff on the Bykow peninsula in the latitudes of the mouth of the Lena, still retains in large part the feathers of the nape, the neck and the breast of its first plumage while those of the occiput and back are already changed, and have their basal portions black and their broad edges of a bright brownish red. The two males captured by Dr. Walter, 21 August 1900, on the west coast of Taimyr, appear to be in full moult although their primaries have not yet attained their normal length, and their newly growing feathers of the occiput and back, under tail-coverts, as well as secondaries and their coverts, which are not moulted, have wide borders of a very fresh reddish-brown tint. The male, killed in the same region ten days later (1 September 1900) has already completed its moult to winter plumage and the russet edgings of its new dress have already had time to fade slightly; we note the same thing also in the specimen of 6 September 1900 from Middendorff Bay of western Taimyr.

Brief mention should be made of the specimens collected by Brusneff in the spring of 1902 in the latitudes of the Yana mouth. Of the pair killed 26 April 1902 at Kasachje, the plumage of the male is much worn so that the feathers of the back and the scapulars have only whitish borders, while the russet tint remains on the occiput only; the female carries a much better-preserved plumage as shown by the rather broad edgings on the feathers of the back which are of a grayish white, while the brownish-russet tint, though very light, remains only on the occiput, scapulars and secondaries. The male, taken fourteen days later (10 June 1902) at the mouth of the river Elijdep had already lost all the bright edgings of its feathers, and its back, scapulars, remiges and rectrices are pure black, that *is*, it was in full summer dress.

Although the Snow Bunting has been noted in all parts of the Eurasian tundra, it is not everywhere equally distributed, but has a preference for certain habitats. Its habit of placing its nest at a certain depth among stones or in the crevices of boulders causes it to avoid all those shores of the Arctic Ocean of sedimentary formation and thus to seek those places where, at sea level or at some distance above sea level in the neighboring mountains, it finds broken rock. (The figure, Plate 17, fig. 1, shows the strata of weathered diabase on Kuzkin Island, near Dickson Bay, as a favorite nesting place of the Snow Bunting.) On account of this predilection for rocky formations, the Snow Bunting has become chiefly a dweller on the seacoast. Even at an altogether insignifi-

cant distance from the shores of the Arctic Ocean, it becomes exclusively a bird of passage, and so careful an observer as Brusneff has noted, for the environs of Kasachje (Yana River system), that the Snow Buntings arrived there in 1902 on 28 March but all disappeared toward the latter half of May, evidently to reach more suitable nesting places. On the mountain-tops there are the rocky moraines of the alpine region; on the seashores either the areas of broken rock, diabase, gneiss or granite, or else the piles of driftwood in which the Snow Bunting makes and carefully hides its nest as a protection from its arch enemies the arctic foxes and the Jaegers (*Stercorarius*).

As proof of the very local distribution of the Snow Bunting, Birula (*l.c.*) informs us that this bird nests much more plentifully in the western part of Kotelny Island than in the eastern. This latter is covered chiefly with wet sandy alluvium, while the rocky beds of Silurian and Devonian limestone and sandstone outcrop chiefly along the western coast of Kotelny Island, on Bielkovski Island and the little island of Strischow. Outcrops of rock strata are also found in the interior of Kotelny Island, on Great Ljakoff Island and on Faddejefski Island. All these places are the preferred nesting haunts of the Snow Bunting and are frequented by an unusual number of these birds. But this does not prevent their nesting at times, though in less numbers, either in the clefts formed by the erosion of the sandy or muddy hills (locally known as *baidsharaki*), or among the piles of driftwood on the seashore.

The dates, rather few, of the arrival of the Snow Bunting in the Eurasian tundra are brought together in the appended table. These allow us to conclude only (1) that the Snow Buntings first appear singly, and that the great part of them arrive much later in the season; and (2) that the time of their arrival varies according to the climatic conditions from year to year. In conformity with these conclusions, I have thought it best to separate the dates of arrival of these first individuals from those of the main migration and then to subdivide each of these categories into three sections: premature dates (for favorable years), normal dates, and late dates (for unfavorable years).

As previously noted, the Snow Bunting arrives first between 27 March and 9 April on the Murman coast of Russian Lapland which in the first place is situated in the middle latitudes and in the second is favored by the influence of the eastern branch of the Gulf Stream. In the interior of Lapland (Russian, Finnish and Swedish) the Snow Bunting nests exclusively in the alpine zone on the summits of the mountains bare of vegetation whence, unfortunately, there are no observations as to the time of its arrival, which would be very interesting to compare with observations made along the seacoast in order to throw light on the influence of the Gulf Stream on the premature arrival of the birds of passage on the shores of the Arctic Ocean.

The other data shown by the table need no explanation, except perhaps those from

Arrival of the Snow Bunting in the Tundra Region.

		Spitzbergen	Bear Island	Kola Peninsula (Murman Coast)	Nova Zembla	Franz Josef Archipelago	Mouth of Yenisei	Western Taimyr	New Siberian Archipelago			Chukche Peninsula
									Kotelny Island	Faddejefski Island	Island of New Siberia	
Section		I	II	III	VIII	IX	XI	XII		XVI		XXI
Arrival of single individuals	Early	29 Mch 1910[1] 3 Apl[4] 12 Apl 1900[3]		Alexandrovsk, 23 Mch 1900[7]		Cape Flora, 16 Apl 1897[13]					17 Apl 1915[58]	
	Normal	20–21 Apl 1912[4] 21 Apl 1900[3]	Apl 1866[6]	Yeretiki, 1 Apl 1896[7] 9 Apl 1900[7] Alexandrovsk, 3 Apl 1901[7]	11 Apl 1883[8]	20–25 Apl 1882[12] Cape Flora, 20 Apl 1895[13] 22 Apl 1896[13]					2 Apl 1915[58]	24 Apl 1879[25]
	Late	6 May 1900[3]			3 May 1833[9] 12 May 1903[10]	"Fram," 84° 17′ N. 25 Apl 1896[14]		Winter-quarters of "Sarja," 2 May 1901[16] Between this and Chelyuskin, 2 May 1901[17]				
Arrival in abundance and in flocks	Early	21 Apl 1912[4]						Cape Wild, 75° 40′ N.; 91° 26′ 3″ E 27 Apl 1915[18] 76° 41′ N., 100° 50′ E. 27 Apl 1915[19]				
	Normal	27 Apl 1887[5]				Cape Flora, 27 Apl 1895[13] 27 Apl 1896[14] Nansen's winter-quarters, 30 Apl 1896[14]	North of Dickson Bay, 7 May 1901[15]	Winter-quarters of "Sarja" 30 May 1912 June 10 1901[16,20]	Chukotskaja R., 29–30 Apl 1902[21] Nerpalach, 10 May 1902[22]	29 Apl 1903[23]	4 May 1903[24] 26–27 Apl 1915[58]	7–19 May 1879[25]
	Late	11 May 1900[3]									7 June 1902[49]	

[1] Münsterhjelm, Öfv. Finska Vet.-Soc. Forh., vol. 53, p. 20, 1910.
[2] Nordenskjöld, Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 2, no. 18, p. 59, 1875.
[3] Observation of Dr. Bunge; Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, pp. 308, 310, 1902.
[4] Observation of Dr. Rempp; Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 96, 1913.
[5] Observation of Dr. Pike; Chapman, Wild Norway, p. 348, 1897.
[6] Observation of Mr. Tobiesen; Fries and Nystrom, Svensk. Polar-Exp. År 1868, p. 40, 1869.
[7] Goebel, Ornith. Jahrb., vol. 12, p. 213, 1901.

the Franz Josef archipelago. In 1896 the first Snow Bunting appeared at Cape Flora on 22 April and the bulk of them arrived 27 April; on 25 April single individuals were seen in the vicinity of the "Fram" in 84° 17′ of north latitude, and five days later, 30 April, they appeared at the winter-quarters of Dr. Nansen. These dates are thus quite in accord.

The shortness of the arctic summer makes it urgent that the Snow Buntings should begin their nest building immediately upon their arrival. They are perhaps already mated before or during migration, because upon reaching the nesting place pairs occupy the chosen spots. The female is the more retiring and gathers the material from which she constructs the nest, while the male occupies some conspicuous point of rock, gives forth his song, and rises, singing, into the air, only to drop back hovering on trembling wing (nearly in the manner of a Pipit, *Anthus*) to seek his mate and accomplish the duties of the breeding season. From the excellent photograph and from the data as to the situation of the nest, cited above, the reader will be able to gather an accurate notion of this matter. I will therefore only add here that the nest is but rarely found under a clump of moss or grass, the usual situation for the nest of the Lapland Longspur or the Pipits (*Anthus*). The crevices between rocks, used by the Snow Bunting must first of all be very narrow (almost always so narrow that a man's hand cannot pass so that in order to reach the nest the surrounding stones must first be removed), and next the cavity is always rather deep. Apparently all these precautions are taken for protection against the arctic foxes (*Alopex lagopus*), the Jaegers (*Stercorarius*) and the Glaucous Gulls, *Larus glaucus* (=*hyperboreus*) that do not hesitate to devour the eggs and young when the nest is insufficiently protected.

As to notes on the time of nesting of the Snow Bunting in the different sections of the Eurasian tundra region, I have thought best to arrange these after the plan lately pro-

[8] Kriwoscheja, Nature and Hunting, 1884, no. 11, p. 39 (in Russian).
[9] Observation of Mr. Pachtussow, Mem. Hydrogr. Dept., vol. 1, p. 99, 1842.
[10] Schaanning, Bergens Mus. Aarb., 1907, no. 8, p. 32.
[11] Jackson, A Thousand Days in the Arctic, vol. 2, app., p. 397, 1899.
[12] Markham, Proc. Roy. Geogr. Soc. London, vol. 5, p. 210, 1883.
[13] Clarke, Ibis, ser. 7, vol. 4, pp. 255, 276, 1898 (observation of Dr. Koettlitz).
[14] Collett and Nansen, Norw. North Pol. Exp., pp. 24, 44, 1899.
[15] Kolomeitzeff, 1902, *l.c.*
[16] Dr. Walter, 1902, *l.c.*
[17] Toll, 1909, *l.c.*
[18] Trzemeskij, Exp. Eclipse, p. 31, 1916 (in Russian).
[19] Starokadomski, Through the Arctic Ocean, pp. 14, 66, 1916 (in Russian).
[20] Birula, 1907, *l.c.*
[21] Observation of Lieutenant Matiessen, Toll, 1909, *l.c.*
[22] Dr. Katin-Jartzeff, *in litt.*, and Toll, 1909, *l.c.*
[23] Tolstow, *in litt.*
[24] Brusneff, 1904, *l.c.*
[25] Palmén, Sibir. Ishk. Fogelf. Vega Exp., p. 282, 1887.
[26] Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 25, 1927 (in Russian).

posed by V. Bianchi and which he has illustrated in the case of the species of the genus *Sylvia* in the Petrograd Government. Since this method is doubtless still but little known I append a somewhat detailed explanation of it. The method proposed by V. Bianchi to show the time of propagation in birds requires as a basis of observation the following conditions: first of all the incubation period for the eggs of the species in question must be known with a fair degree of accuracy; then in the second place the length of time between hatching of the young and the moment when they leave the nest. In case of our Snow Bunting the observers, as Römer and Schaudinn, and Professor König, agree that these two periods have a duration each of about fourteen days. The dates of original observations are expressed in our table in italic type, those inferred are in ordinary type. The object is to determine from the exact date of the original observation the approximate dates of the four following stages in the process of reproduction of the species: (1) the moment when the set of eggs is complete; (2) the time when the young hatch; (3) the time when they have attained approximately half their full size; (4) the time when they leave the nest. In the simplest cases we proceed as follows: Bianchi refers to an observation according to which Dr. Bunge found a complete set of fresh eggs of the Snow Bunting on 16 June at Spitzbergen. From this original date we calculate that in fourteen days, that is, 30 June, the young should hatch; seven days later, 7 July, they should attain half their adult size; and after another seven days, or 14 July, they should leave the nest. These deductions make it possible to make use of a much greater number of data which in their turn permit us to divide the data for each of the four periods of propagation into premature, normal and late dates. In Spitzbergen, for example, we may suppose, according to our table, that in the exceptionally favorable years there are sets of eggs already completed about 1 June; that normally they are completed between 8 and 16 June, and that in the unfavorable years they are only complete between 20 June and 3 July. The dates for the late sets are obviously the least exact because they must depend not only upon the unfavorable climatic conditions of the years in question but also these must sometimes be second sets, especially in cases where the first attempts at nesting have miscarried. But the field naturalists provide us with data not only in terms of the four fixed periods but sometimes in such wise as "nest with four fresh eggs," "eggs slightly incubated," "eggs heavily incubated," "eggs with large embryos," which makes it necessary to introduce the following corrections: for the first of these cases (sets of eggs incomplete) the observation of Dr. Bunge[m] at the mouth of the Lena River may serve us as an example. The 27 June he found a set of four fresh eggs which permits us to infer that this set should be completed, that is, attain the normal number of six eggs, about 29 June. In citing the exact date of the observation and expressing it in *ordinary* type we

Incubation period 14 days Young leave nest in about 14 days		Spitz-bergen	Bear Island	Kola Peninsula	Kolguev Island	Vaigach Island	Nova Zembla	Franz Josef Archipelago	Western Taimyr Peninsula	Mouth of Lena	New Siberian Archipelago			Mouth of the Kolyma
											Great Ljakoff	Kotelny Island	Island of New Siberia	
No. of Section		I	II	III	V	VII	VIII	IX	XII	XIV	XVI	XVI	XVI	XIX
The set completed	Early dates	2 Je 1882[1]			14 Je 1894[13]	1 Je 1897[15] 4 Je 1897[15]	23 Je 1903[16] (no eggs) *20 Je 1903* (1 egg) 26 Je 1903[16]	12 Je 1897[19]						
	Normal dates	8 Je 1873[2] 10 Je 1893[3] *15 Je 1903*[4]		*2 Je*[12] *5 Je*[13] 11 Je 1923[23] *16 Je 1922* 3 Je[12] *13 Je*[22]	17 Je 1895[14] *21 Je 1894*[13] 21 Je 1895[14] *24 Je 1894*[13]		28 Je 1895[17] *25 Je 1903*[16] (1 egg) 30Je1903[16] *27 Je 1903* (1 egg) 2 Jy 1903[16] 4 Jy 1907[14]	*22 Je 1895*[19] *23 Je 1895*[20] 28 Je 1896[19]	*23 Je 1901*[21] 25 Je 1843[22] 29 Je 1843[22] *29 Je 1843* (set compleateabout 1Jy 1843)[22]	*27 Je 1883*[23]	25 Je 1886[24] 27 Je 1886[24]	App. 16 Je 1903[26] *23Je1903*[26] (slightly incubated) 26 Je 1902[25]	16 Je 1903[26] 20 Je 1903[26] 25 Je 1902[27] *26 Je 1903*[26] (well incubated) *26 Je 1903*[26] (incubated)	19 Je 1912[28]
	Late dates	20 Je 1921[30] 20 Je 1910[5] *20 Je 1898*[6] 22 Je 1908[4] 23 Je 1910[7] *24 Je 1910*[5] 26 Je 1898[8] 27 Je 1906[7] *29 Je 1900*[8] 29 Je 1861[9] *30 Je 1910*[5] 1 Jy 1881[10] 2 Jy 1923[31] 3 Jy 1881[10]	29 Je 1899[11] *6 Jy 1899*[21] (slightly incubated) (much	incubated)			*5 Jy 1903* (1 egg) 10Jy1903[16] *24 Jy 1895*[14]		11 Jy 1843[22]					
Time of hatching	Early dates	16 Je 1882[1]			28 Je 1894[13]	15 Je 1897[15] 19 Je 1897[15]	*8 Jy 1903*[16] 9 Jy 1903[16]	26 Je 1897[19]						
	Normal dates	22 Je 1873[2] 24 Je 1898[3] 29 Je 1908[4]		16 Je[12] 17 Je 1922[23] 19 Je[12] 25 Je 1922[23]	1 Jy 1895[14] 5 Jy 1894[13] *5 Jy 1895*[14] 8 Jy 1894[13]		12 Jy 1895[17] 15 Jy 1903[16] 16 Jy 1903[16] 18 Jy 1907[14]	6 Jy 1895[20] 7 Jy 1895[20] 11Jy1896[19]	7 Je 1901[21] 9 Jy 1843[22] 13 Jy 1843[22] 15 Jy 1843[22]	11 Jy 1883[23]	*9 Jy 1886*[24] *11 Jy 1886*[24]	30 Je 1903[26] 10 Jy 1902[25]	30 Je 1903[26] 4 Jy 1903[26] 9 Jy 1902[27]	(3 Jy 1912[28] *6 Jy 1912*[28] (young 3 days old)
	Late dates	4 Jy 1921[30] 4 Jy 1910[5] 4 Jy 1898[6] *5 Jy 1904*[4] 7 Jy 1910[7] 8 Jy 1910[5] 10 Jy 1898[6] 11 Jy 1906[7] 13 Jy 1906[8] 13 Jy 1861[9] 15 Jy 1881[10] 16 Jy 1923[31] 17 Jy 1881[10]	13 Jy 1899[11]				24 Jy 1903[16] 7 Ag 1895[17]		25 Jy 1843[22]					

Young half grown	Early dates	23 Je 1882[1]			5 Jy 1894[14]	22 Je 1897[15] 26 Je 1897[15]	15 Jy 1903[16] 16 Jy 1903[14]	3 Jy 1897[19]							
	Normal dates	*29 Je 1873*[2] *1 Jy 1898*[3] 6 Jy 1908[4]		23 Je[42] 24 Je 1922[22] 26 Je[42] 1 Jy 1922[22]	8 Jy 1895[14] 12 Jy 1894[13] 12 Jy 1895[14] 15 Jy 1894[13]		19 Jy 1895[17] 21 Jy 1903[16] 23 Jy 1903[16] 25 Jy 1907[18]	13 Jy 1895[20] 14 Jy 1895[20] 19 Jy 1896[19]	14 Jy 1901[24] 16 Jy 1843[22] 20 Jy 1843[22] 22 Jy 1843[22]	18 Jy 1883[23]	16 Jy 1886[24] 18 Jy 1886[24]	7 Jy 1903[16] 17 Jy 1902[25]	7 Jy 1903[16] 11 Jy 1903[16] 16 Jy 1902[27]	10 Jy 1912[29]
	Late dates	11 Jy 1921[30] 11 Jy 1910[5] 11 Jy 1898[6] 12 Jy 1908[4] 14 Jy 1910[5] 15 Jy 1910[5] 17 Jy 1898[6] *18 Jy 1906*[7] 20 Jy 1908[8] 20 Jy 1861[9] 22 Jy 1881[10] 23 Jy 1923[31] 24 Jy 1881[10]	20 Jy 1899[11]				31 Jy 1903[16] 14 Ag 1895[18]		2 Ag 1843[22]						
Young leave the nest	Early dates	*30 Je 1883*[6]			12 Jy 1894[13]	*29 Je 1897*[15] *3 Jy 1897*[15]	22 Jy 1903[16] 23 Jy 1903[16]	*16 Jy 1897*[19]							
	Normal dates	6 Jy 1873[2] 8 Jy 1898[3] 13 Jy 1908[4]		30 Je[42] 1 Jy 1922[22] 3 Jy [42] 8 Jy 1922[22]	*15 Jy 1895*[14] 19 Jy 1894[13] 19 Jy 1895[14] 22 Jy 1894[14]		*26 Jy 1895*[17] 28 Jy 1903[16] 30 Jy 1903[16] *31 Jy 1907*[18]	20 Jy 1895[20] 21 Jy 1895[20] *25 Jy 1896*[19]	14–29 Jy 1901[24] 21Jy1901[24] 23 Jy 1843[22] *27 Jy 1843*[22] 29 Jy 1843[22]	25 Jy 1883[23]	23 Jy 1886[24] 26 Jy 1886[24]	14 Jy 1902[25] *24 Jy 1902*[25]	14 Jy 1903[16] 18 Jy 1903[16] *23 Jy 1902*[27]	17 Jy 1912[29]
	Late dates	*18 Jy 1921*[30] 18 Jy 1910[5] 18 Jy 1898[6] 19 Jy 1908[4] 21 Jy 1910[5] 22 Jy 1910[5] *24 Jy 1898*[6] 25 Jy 1906[7] 27 Jy 1900[8] *27 Jy 1861*[9] *29 Jy 1881*[10] *30 Jy 1923*[31] 31 Jy 1881[10]	27 Jy 1899[11]				7 Ag 1903[16] 21 Ag 1898[18]		*9 Ag 1843*[22]						

1 Nathorst, Bih. Kongl Svensk. Vet.-Akad Handl., vol 9, no 2, p 25, 1884—77° 6′ N. L
2 Eaton, Zool., 1874, p 4805, 80° 6′ N. L
3 Kuthof, Kongl. Svensk Vet.-Akad Forh., vol 37, no 9, p 34, 1910
4 Kong. Acad. Skrifter, p. 118, 1911
5 Munsterhjelm, Oefvf. Finska Vet. Soc. Forh., vol. 53, p. 20, 1910
6 Romer and Schaudinn, Ornith. Monatsb., vol. 8, p. 101, 1900
7 Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, no 38, p. 144, 1911
8 Observations of Dr. Bunge. Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol 7, p. 311, 1902.
9 Malmgren, Journ. f. Ornith., vol 13, p. 370, 1865. 80° 24′ N. L
10 Cooke, Zool., 1882, p. 107
11 Swenander, Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 26, pt. 4, no. 3, p. 13, 1900
12 Goebel, Mem. Soc. Nat. St. Petersbourg, vol. 23, p. 128, 1902 (in Russian)
13 Trevor-Battye, Ice-bound on Kolguev, pp. 65, 91, 420, 1895.
14 Pearson, Beyond Petsora Eastw., app. G, p. 312, 1899
15 Pearson, Ibis, ser. 7, vol. 4, p. 193, 1898
16 Johansson, Bergens Mus. Arrh., 1907, no. 8, p. 32
17 Pearson, Ibis, ser. 7, vol. 2, p. 220, 1896
18 Molchanow, Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 314, 1908.
19 Clarke, Ibis, ser. 7, vol. 4, p. 255, 1898.
20 Jackson, A Thousand Days in the Arctic, vol. 2, app., p. 389, 1899
21 Walter, *l. c.*
22 Middendorff, Sibir. Reise, vol. 2, pt. 2, p. 134, 1853
23 Bunge, Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 44, 1884.
24 Bunge, Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 279, 1887
25 Dr. Katin-Jartzeff, *in litt*
26 Nest and set collected by Olenin
27 Birula, *l. c.*
28 Nests and sets collected by Brusnoff.
29 Thayer and Bangs, Proc. New England Zool. Club, vol. 5, p. 46, 1914.
30 Journinin, Ibis, ser. 11, vol. 4, p. 162, 1922
31 Langstaff, Ibis, ser. 11, vol. 6, p. 482, 1924 (Hinlopen Strait).
42 Collection of B. Kapustin

enclose it in a parenthesis with the conjectural date and then calculate the dates of the three other fixed periods of propagation from this last date. In the second case, "eggs slightly incubated," as in the case of a set found by Olenin[26] on 23 June at Kotelny Island, we assume that it was completed on 16 June and make our calculations from that date. For those eggs well advanced in incubation, found by Brusneff[28] the 26 June on the Island of New Siberia we make a deduction of ten days, so as to reckon on starting 16 June. Finally, in the cases where the observers noted large embryos well developed, as in the two sets found by Dr. Bunge[24] on 7 July and 8 July at the Ljakoff Islands, we add three days and assume that these two sets of eggs hatch about 10 and 11 July, then finally we compute from these dates those of the three other periods of propagation.

Our table on the breeding of the Snow Bunting gives us ground for drawing the following conclusions: first, as we should have anticipated, the sets of eggs of the Snow Bunting are normally the soonest completed (between 2 and 11 June) on the Murman coast of Russian Lapland, quite in accord with the earliest arrival of the Snow Buntings in these latitudes in spring. Next in order comes Spitzbergen, which on its western coast enjoys the influence of the eastern branch of the warm Gulf Stream; there the sets of eggs are usually complete between 8 and 16 June. According to the observations of Langstaff (Ibis, 1924, p. 482) it appears that in the northern parts of Spitzbergen (Hinlopen Strait) the breeding season is about two weeks later. On Kolguev Island egg-laying is a little later and is not complete until between 17 and 24 June. For the Franz Josef archipelago, projecting far toward the North Pole, and for Western Taimyr, situated fairly near the coldest countries of the globe, the normal dates are a few days later still, and fall between 22 and 28 June for the first and between 23 June and 1 July for the second. We may next conclude that for the coasts and islands of the eastern parts of the Eurasian Arctic Ocean the normal dates are several days earlier and at the mouth of the Lena River come between 19 and 29 June and at the New Siberian archipelago and the mouth of the Kolyma between 16 and 27 June. We can likewise state that there is no difference between the dates for the several islands of the New Siberian archipelago or that such difference is very small and insignificant. Finally the table shows that apparently the Snow Bunting nests latest of all in Nova Zembla and that the exceptionally early sets of eggs there are not complete until 23 to 25 June, the normal sets between 29 June and 4 July and the late ones 10 July and even sometimes 24 July. According to Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 32) who has recorded the first young hatched 30 June 1903; the same author informs us also that the young first left the nest 24 July 1903. According to Gorbunow (*in litt.*) well-flying young were observed at Belushja Bay (Nova Zembla) 5 August 1925. Finally I must cite a very

curious fact, communicated by Schaanning, that in one nest which on 23 June contained no eggs, he found on 8 July, five nestlings. We are thus forced to conclude that the laying of five eggs and their incubation had taken only fifteen days, a period obviously too short, in view of the fact that incubation usually lasts fourteen days.

The construction of the nests of the Snow Bunting is everywhere the same. I have carefully compared the nests collected by the Russian Polar Expedition with those from Spitzbergen, the Franz Josef archipelago, Nova Zembla, Taimyr and the mouth of the Lena and I have been unable to find any marked difference. Among those examined I have not succeeded in discovering among the material composing the nest lining any trace of the hair of the polar bear, as found in those from Spitzbergen by Professor König and those from the Franz Josef archipelago by Jackson. As to the eggs of the Snow Bunting, they vary very greatly, so that almost every set has its own peculiarities, and even in the same set one may find eggs of very different types.

Following is a detailed description of the nests and eggs collected by the Russian Polar Expedition.

1. 23 June 1901, west shore of Taimyr Strait (Dr. H. Walter).—The materials of the nest comprise two layers: the external layer, built of blades of dried grasses of the preceding year, interwoven with bits of moss and lichens; the inner layer, made of finer and fresher blades of grasses or sedges; the lining is abundantly furnished either with separate hairs or with tufts of hair of the wild reindeer and a few feathers, among which I was able to identify tail-feathers of *Anthus cervinus* Pallas and some feathers from the summer plumage of a female of the Rock Ptarmigan, *Lagopus rupestris* (Gmelin). The nest is 144 mm. in long diameter, by 120.5 mm. in greatest width; the length of the cavity is 84 mm., its width 77. It contained five fresh eggs, of the following dimensions and weights: 20 mm. x 16.8 (20 eg.); 20 x 16.7 (20 eg.); 19.5 x 17 (19.9 eg.); 20 x 16.8 (19.8 eg.); 21.1 x 16.5 (20.1 eg.). The eggs are rather uniform in coloration. Their ground color is white with a very light greenish-gray tint; the deeper spots are a dark écru (Ridgway, Nomencl. Colors, ed. 2, Pl. 46, drab gray); the superficial spots, black with chestnut reflections, are concentrated at the large end in the form of speckles and zigzags.

2. 23 June 1903, Camp Jegoroff, Kotelny Island (P. Olenin).—In this nest the two usual layers are not distinct. It is made of blades of dry grass left from the preceding year interwoven with bits of moss and lichens. The lining is formed of a small amount of hair of the wild reindeer and with an abundance of feathers of the Snowy Owl (*Nyctea nyctea* (Linné), one feather of the Brant (*Branta bernicla nigricans* (Lawrence)) and some feathers of Gulls (*Larus glaucus* Linné (=*hyperboreus* Gunnerus) or *L. argentatus birulai* Sushkin). The nest has a length of 114 mm. and a breadth of 102 mm. The cavity is 73

mm. long and 68 mm. wide. The nest contained seven eggs, slightly incubated, four of which were measured but could not be weighed on account of their faulty preservation. The dimensions of the eggs are: 22 mm. x 16; 22.5 x 16; 22.2 x 16; 22 x 16. The eggs of this set are also fairly uniform in coloration; the ground color is white with a very bright greenish-gray tint; the deeper spots are of an écru color (écru drab, Ridgway, Pl. 46) with superficial dots scattered over all of them of a black color with a chestnut reflection and with larger comma-shaped spots wholly black.

3. Date ?, Camp Jegoroff, Kotelny Island (*P. Olenin*).—This nest has the two layers very distinct; the external layer is formed of the more solid blades of dry grasses of the previous year and the inner layer of the same blades but fresh and finer. The lining is made of the white feathers of a Willow Grouse and of the hair of the wild reindeer. The nest is nearly round, its length 104.5 mm. and its width 99 mm. The opening of the cavity is 56 mm. long and 45 mm. wide. The nest contains seven eggs slightly incubated, the measurements of six of which it was possible to obtain; because of their insufficient preparation I have hesitated to weigh them. They measure: 23.5 mm. x 16.4; 23.1 x 17; 23 x 17; 24.8 x 17; 23.1 x 16.2; 23 x 16.3. The ground color of the eggs is white with a faint tinge of greenish gray; the deeper spots are of a fawn color (Ridgway, Pl. 40); the superficial spots consist of a limited number of points of a dark brownish black.

4. 26 June 1903, Derewjannyja Mountains, Island of New Siberia (*Brusneff*).—This nest is composed likewise of two layers. The outer layer is made of the blades of dry grasses of the previous year having a grayish tint, interwoven with bits of moss and lichens; the inner layer, composed of fresher material, is of a yellowish tint. The lining is chiefly made of hair of the wild reindeer, together with some feathers of the winter and summer plumage of the Willow Grouse. The nest is perfectly round, measuring in its two diameters 125 mm.; the cavity is 73 mm. long and 70 wide. The nest contained six incubated eggs, three of which were broken in preparation so that the determination of the weight of the shells was not possible. They measure: 22 mm. x 16; 23 x 16.1; 23 x 16.1. The eggs have a white ground with a faint greenish-gray tint; at the larger end there is a ring of small spots of a clay color (Ridgway, Pl. 29).

5. 26 June 1903, Derewjannyja Mountains, Island of New Siberia (*Brusneff*).—This nest differs from the others in its more compact construction. It is made of the blades of dry grasses of the previous year and has only a single layer. The lining consists chiefly of hair from the wild reindeer and of white feathers of the Willow Grouse and the Snowy Owl and of tufts of silky white hair from the arctic fox (*Alopex lagopus*). The nest is almost round with a length of 113 mm. against 111 mm. in breadth; the cavity measures 69 mm. long by 60 in width. The nest contained five heavily incubated eggs with the following dimensions and weights: 22.5 mm. x 16; 22.5 x 16 (20 cg.); 21.2 x 16;

22 x 16.1 (20 eg.); 22.5 x 16.1 (20 eg.). The ground color of the eggs of this set is white, tinted with grayish écru; the deeper spots of larger size are écru drab (Ridgway, Pl. 40) and the smaller superficial spots are sometimes of a fawn color (Ridgway, Pl. 40), sometimes of a darker brown (Ridgway, Pl. 15, Prout's brown), sometimes even almost black.

6. 23 June 1903, Faddejefski Island (*S. Tolstow*).—The nest is relatively small, and represents only an oval platform which is rather shallow. It is formed chiefly of the blades of a species of grass abundantly interwoven with feathers of the Willow Grouse, and tufts of the fur of the lemming (*Dicrostonyx torquatus*) and is furnished with the hair of the wild reindeer in addition. The nest is 114.5 mm. long by 92 wide; the cavity measures 76.5 mm. long by 69 wide. The set of eggs probably was not complete since it consists of only four, on the state of incubation of which we have no data. The eggs show the following dimensions and weights: 25 mm. x 16.1 (21 eg.); 24.2 x 16.1 (21 eg.); 24.3 x 16.1 (21.5 eg.); 24 x 16.1 (21 eg.). The ground color of these eggs is white with a faint tinge of écru; the deeper spots are very small and of a pale écru color (Ridgway, Pl. 46, pale écru drab), the superficial spots, which are more numerous at the pointed end, and form a ring around the larger end, are a liver-brown color (Ridgway, Pl. 14) with spots of hazel (Ridgway, Pl. 14).

7. 27 June 1903, Faddejefski Island (*S. Tolstow*).—The nest is so very much out of shape that I hesitate to measure and describe it. Likewise the eggs of this set can neither be measured nor weighed on account of their bad state of preservation but they are of particular interest because of their coloration. One of them has a white ground with a pale tinge of pearl gray and with spots washed with very clear écru (Ridgway, Pl. 46, pale écru gray); the second egg has the same ground color with more heavily marked spots of liver brown and some irregular superficial spots of a blackish brown. The four remaining eggs have a ground color of fawn (Ridgway, Pl. 40), with pale spots of a darker tint of the same color, sometimes on a transparent whitish ground. The superficial spots which are the darkest are concentrated at the large end and sometimes one may see some scattered spots in the shape of commas which are almost black.

According to our table of the chief periods of propagation of the Snow Bunting we may conclude that the young normally leave their nests on the Murman coast between 30 June and 3 July; at Spitzbergen a little later, between 6 and 14 July. Farther eastward it is almost everywhere in the second part of July, between 14 and 31 July, that this leaving of the nest takes place. At the period when the young are nearly fledged the adult birds begin obviously to change their worn summer plumage for the plumage of autumn and winter; at the same time a partial moult begins to take place in the young birds of which I have already spoken in describing the specimens from the collection of the Russian Polar Expedition. I have not at hand any original observations on the duration and end

of the moult in the Snow Bunting and I must therefore limit myself to saying that the two specimens taken by the late Dr. Walter 21 August 1900, in the latitudes of Western Taimyr, had not yet completed their moult. Before leaving the region of their birth, the tundra, the Snow Buntings gather into little flocks in preparation for their distant journey. For Nova Zembla this fact was observed by Mr. Gorbunow (*in litt.*) 14 September 1923. According to the observations of Birula (1907), the adult birds must in

Dates of Departure of the Snow Bunting from the Tundra.

	Spitzbergen	Bear Island	Kolguev Island	Nova Zembla	Franz Josef Archipelago	Mouth of Yenisei	Western Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	
										Great Ljakoff	Kotelny Island
Section	I	II	V	VIII	IX	XI	XII	XIV	XV	XVI	XVI
Time of nomadic life in flocks, preparatory to migration	17 Ag. 1910[1] 20 Ag. 1910[2]	26 Ag. 1899[3]	3 Ag. 1894[4]	6 Ag. 1895[7]			23 Ag. 1843[10a]			28 Ag.–8 Sep. 1886[16]	4 Sep. 1902[17]
Time of main migration	27 Sep. 1899[5] 7 Oct. 1899[2] 28 Sep. 1882[9]				2 Oct. 1896[3] 6 Oct. 1895[8] 14 Oct. 1896[9]	27 Ag. 1914[10]	6 Sep. 1900[11] 10 Sep. 1900[12] 11 Sep. 1900[13] 16 Sep. 1843[10a] 21 Sep. 1900[14]	21 Sep. 1882[13]		15 Sep. 1886[16]	
Departure of the last birds	17 Oct. 1889[4] 19 Oct. 1899[2] 25 Oct. 1899[3]				30 Oct. 1896[9]		27 Sep. 1900[11] 29 Sep. 1900[11] 30 Sep. 1900[13] 2 Oct. 1900[14]	1 Oct. 1882[14]	19 Sep. 1885[15]	22 Sep. 1886[16]	

[1] Münsterhjelm, Oefv. Finsk. Vet.-Soc. Forh., vol. 53, p. 20, 1910.
[2] Observation of Dr. Bunge; Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, pp. 307, 310, 1902.
[3] Cocks, Zoologist, ser. 3, vol. 8, p. 14, 1884.
[4] Observation of Pike; Chapman, Wild Norway, p. 344, 1897.
[5] Swenander, Bih. Kongl. Svensk. Vet.-Akad. Handl., Stockholm, vol. 26, pt. 4, no. 3, p. 13, 1900.
[6] Trevor-Battye, Ice-bound on Kolguev, p. 420, 1895.
[7] Pearson, Beyond Petsora Eastward, app. G, p. 312, 1899.
[8] Jackson, A Thousand Days in the Arctic, vol. 2, app., pp. 389, 397, 1899.
[9] Clarke, Ibis, ser. 7, vol. 4, p. 255, 1898.
[10] Haviland, Ibis, ser. 10, vol. 3, p. 397, 1915.
[10a] Middendorff, Sibir. Reise, vol. 2, pt. 2, p. 134, 1853.
[11] Birula, *l.c.* 1907.
[12] Walter, *l.c.* 1901.
[13] Toll, *l.c.* 1909, p. 87.
[14] Bunge, Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 597, 1883.
[15] Bunge, Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 109, 1887.
[16] Bunge, *ibid.*, p. 282–283, 1887.
[17] Dr. Katin-Jartzeff, *in litt.*

all probability migrate separately from the young ones because among the Snow Buntings which on 6 September 1900 passed the environs of Middendorff Bay in Western Taimyr, the adult birds sensibly predominated.

The table herewith on the dates of departure of the Snow Bunting in the different parts of the Eurasian tundra demands several explanatory notes. The first portion contains the dates for the period during which the Snow Buntings gather into small flocks and lead a nomadic life. In the second part are found the data on the departure of the main body of the birds while the third part contains the dates as to the last individuals seen.

It only remains to say that the Snow Bunting has been identified at a very high latitude: on 19 June 1895, one was seen by the crew of the "Fram" under 84° 45′ north latitude and 83° 5′ east longitude (Collett and Nansen, Norw. North Pol. Exp., p. 44, 1899).

5. Calcarius lapponicus lapponicus (Linné).

Calcarius lapponicus (Linné). Walter, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902; Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 239, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 4, 5, 8, 11–14, 17–18, 144, 1907. Toll, Die russ. Polarf. d. "Sarja," p. 326, 1909.

Plectrophanes lapponicus. Brusneff, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 7, p. 181, 1904.

List of Specimens from the Russian Polar Expedition.

Skins: adult male, 14 June 1901, adult female, 18 June 1901, adult female, 24 June 1901, adult male 12 July 1901, adult female, 28 June 1901, all from west shore of Taimyr Strait (Dr. H. Walter); adult female, 17 June 1902, adult female, 19 June 1902, adult male, 30 June 1902, all from Nerpalach Bay, Kotelny Island (Dr. V. Katin-Jartzeff); adult male, 14 August 1902, New Siberia Island (A. Birula); adult male, 21 June 1903, Faddejefski Island (S. Tolstow); adult males and females, 2 June 1901, Maloe-simowje, Great Ljakoff Island (O. Gionglinski); adult female, 8 June 1902, Elijdep peninsula, mouth of the Lena (M. Brusneff); unfeathered young, 8 June 1902, same place; young, 23 July 1902, valley of the Charaulach River (M. Brusneff); adult female, mid-May 1903, mouth of the Lena (Th. Matiessen).

In spirits: unfeathered young, 23 July 1902, valley of the Charaulach River, mouth of the Lena (M. Brusneff).

Nests and eggs: nest with five eggs, 24 June 1901, nest with five eggs (six), 28 June 1901; five eggs, 12 July 1901, all from the west shore of Taimyr Strait (Dr. H. Walter); nest with six eggs, 19 June 1902, Nerpalach Bay, Kotelny Island (Dr. V. Katin-Jartzeff); nest with five eggs, 23 June 1903, Faddejefski Island (S. Tolstow); nest with five eggs, 15 June 1902, Elijdep peninsula (M. Brusneff); nest with 3 eggs, 17 June 1903, Bykow peninsula (Th. Matiessen).

Local names: in Samoyede, in the Yamal peninsula, *chorako-tibei*, that is to say, decayed breast (Zitkow); in Yakut, *malzaptschi* (Bunge), *tschitschak* (meaning little bird), or *doulonka tschitschaha* (bird of the hillocks); in Tunguse, *tscheukatschan* (Birula); in Chuckche, *tumkup* (Palmén).

The Lapland Bunting has been noticed in seventeen of my sections of the Eurasian tundra region and is lacking, or at least, has not yet been found in three. It is totally absent from Spitzbergen (Sect. I) and from Bear Island (Sect. II) and has not been found, up to the present time, in the De Long archipelago (Sect. XVII); in Wrangel Island

(Sect. XX) its place is taken by *Calcarius lapponicus alascensis* Ridgway. It has been observed and collected by members of the Russian Polar Expedition in the following places: at the winter-quarters of the "Sarja" on the west coast of Taimyr Strait in the spring and during the summer of 1901 (Dr. Walter, 1904, *in litt.* and specimens; Birula, 1907; Toll, 1909); in the Bykow peninsula at the mouth of the Lena River (Matiessen, specimens collected); on the Elijdep promontory, June 1902, and in the Charaulach Mountains, July 1902; at the mouth of the Yana (Brusneff, 1904, *in litt.* and specimens); Great Ljakoff Island, 2 June 1901 (Cionglinski, see list of specimens); in the New Siberian Islands, namely: Kotelny, summer 1902 (Dr. Katin-Jartzeff, *in litt.* and specimens), New Siberia, autumn 1902 (Birula, 1907, and specimens), and Faddejefski, summer 1903 (Tolstow, *in litt.* and specimens).

The specimens brought back by the Russian Polar Expedition are in no wise different from specimens of the same sex and time of year taken in other parts of the Eurasian polar regions. We may, therefore, say merely that the male taken 14 August 1902, on the Island of New Siberia wears a perfectly fresh plumage and is obviously just completing its moult. The dates for arrival of the Lapland Bunting in the different parts of the Eurasian tundra region are so very few that I hesitate to classify them in tabular form. On the Murman coast (Sect. III) according to the data of Goebel (Ornith. Jahrb., vol. 12, p. 213, 1901) this species arrived at Yeretiki, 26 April 1882; 21 April 1884; 16 April 1896; 9 May 1899; and 15 May 1900; and at Alexandrovsk, 28 April 1901. From these data we may conclude that the bird arrives regularly in the second part of April and in the less favorable years, such as 1899 and 1900, in the first part of May. In Western Taimyr (Sect. XII), Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 136, 1853) observed the arrival of the Lapland Bunting 16 June 1843, while in 1901 it appeared there according to Dr. Walter (1902) 13 June and according to Birula (1907), 14 June. In the New Siberian archipelago the advance guard of these birds was noted by Birula (1907) 7 June 1902, at the Island of New Siberia, and the bulk of the birds appeared there 9 June; Tolstow (*in litt.*) observed their arrival at Faddejefski Island 31 May 1903.

The table of the four periods in the propagation of the Lapland Bunting requires the following explanation. First of all I have not at hand any original dates for this species, either as to its incubation period or the time between the hatching of the young and the moment when they leave the nest. I may, however, arrange this table by basing it on the analogy of the exact dates that we have at our disposal for the Snow Bunting. In the second place the notes of Mr. Goebel as to the times of his discoveries of sets of fresh eggs consist, for the two places of his observation, of only general dates for the River Pas (Pasvig-elf) between 5 June and 20 June, and for the Murman coast between 19 June and 15 July. As these dates evidently represent in part unusually early

Breeding of the Lapland Longspur.

Incubation period 14 days Young leave nest after 14 days (approx.)		Kola Peninsula (Murman Coast)	Kolguev Island	Mouth of Ob; Yamal Peninsula	Western Taimyr	Mouth of Lena	New Siberian Archipelago Kotelny Island	Mouth of Kolyma
No. of Section		III	V	X	XII	XIV	XVI	XIX
Set completed	Early dates	*5 Je–13 Je*[1] Pas-elf			21 Je 1901[4]	*17 Je 1903*[8]	*19 Je 1902*[9]	15 Je 1902[10]
	Normal dates	14 Je–20 Je[1] (Murman Coast) *19 Je–3 Jy*[1] 17 Je 1922[4] *27 Je 1922*[4]	*24 Je 1894*[2] 4 eggs 24 Je 1894[2] 27 Je 1894[2]	About 12 Je 15 Je 1908[3] About 14 Je 1908[3]	*24 Je 1901*[4] 26 Je 1843[5] 1 Jy 1843[5]	25 Je 1882[7] 26 Je 1882[7] *27 Je 1882*[7] 30 Je 1882,[7] 3 eggs *30 Je 1882,*[7] 4 eggs 2 Jy 1882[7] *2 Jy 1882,*[7] 3 eggs 5 Jy 1882[7] *4 Jy 1882*[7]		*25 Je 1912*[10] *26 Je 1912*[10]
	Late dates	*3 Jy–15 Jy*[1] –16 Jy[1]			*12 Jy 1901*[4]			
Time of hatching	Early dates	19 Je–27 Je[1] Pas-elf			Incubated 5 Jy 1901[4]	1 Jy 1903[8]	3 Jy 1902[9]	28 Je 1912[10]
	Normal dates	28 Je–4 Jy[1] (Murman Coast) 3 Jy–16 Jy[1] 1 Jy 1920[11]	8 Jy 1894[2] 11 Jy 1894[2]	Approx. 26–29 Je 1908[3] Approx. *28 Je 1908*[3]	8 Jy 1901[4] *7 Jy 1843*[5] (incubation advanced) 10 Jy 1843[5] 15 Jy 1843[5]	*9 Jy 1882*[7] *10 Jy 1882*[7] 14 Jy 1882[7] 16 Jy 1882[7] 18 Jy 1882[7] 19 Jy 1882[7]		9 Jy 1912[10] 10 Jy 1912[10]
	Late dates	17–29 Jy[1]			26 Jy 1901[4]			
Young half grown	Early dates	26 Je–4 Jy[1] Pas-elf			12 Jy 1901[4]	7 Jy 1903[8]	9 Jy 1902[9]	5 Jy 1912[10]
	Normal dates	5 Jy–11 Jy[1] (Murman Coast) 10 Jy–23 Jy[1] 8 Jy 1922[11]	15 Jy 1894[2] 18 Jy 1894[2]	About 3–6 Jy 1908[3] About 5 Jy 1908[3]	15 Jy 1901[4] 17 Jy 1843[5] *22 Jy 1843*[5]	16 Jy 1882[7] 17 Jy 1882[7] 21 Jy 1882[7] 23 Jy 1882[7] 25 Jy 1882[7] 26 Jy 1882[7]		16 Jy 1912[10] 17 Jy 1912[10]
	Late dates	24 Jy–5 Ag[1]			2 Ag 1901[4]			
Young leave the nest	Early dates	3–11 Jy[1] Pas-elf			19 Jy 1901[4]	15 Jy 1903[8]	17 Jy 1902[9]	*12 Jy 1912*[10]
	Normal dates	12 Jy–5 Ag[1] (Murman Coast) 17–30 Jy[1] 15 Jy 1922[11]	*22 Jy 1894*[2] 25 Jy 1894[2]	About *end Je 1908*[3] About 12 Jy 1908[3]	22 Jy 1901[4] 24 Jy 1843[5] 29 Jy 1843[5]	23 Jy 1882[7] 24 Jy 1882[7] 28 Jy 1882[7] 30 Jy 1882[7] 1 Ag 1882[7] 2 Ag 1882[7]		23 Jy 1912[10] 24 Jy 1912[10]
	Late dates	31 Jy–17 Ag[1]			9 Ag 1901[4]			

[1] Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 128, 1902.
[2] Trevor-Battye, Ice-bound on Kolguev, p. 420, 1895.
[3] Zitkow, Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 312, 1912.
[4] Dr. Walter, *in litt. et exempl. coll.*; Birula, *l.c.*, 1907.
[5] Middendorff, Sibir. Reise, vol. 2, pt. 2, p. 136, 1853.
[6] Walter, *in litt. et exempl. coll.*
[7] Bunge, *exempl. coll.*
[8] Matiessen, *exempl. coll.*
[9] Dr. Katin-Jartzeff, *exempl. coll.*
[10] Thayer and Bangs, Proc. New England Zool. Club, vol. 5, p. 46, 1914.
[11] Coll. Kapustin (Mus. Zool.)

ones for favorable years as well as the normal dates and very late dates for unfavorable years, I have tried to divide these into the three categories. I cannot deny that except for the original dates of Goebel all the notes for Sect. III are merely the result of an approximate calculation, but I think, nevertheless, that they approach very nearly the truth and that the sets of eggs of the Lapland Bunting are completed at the following periods: at the Pasvig-elf in favorable years between 5 and 13 June, in the normal years between 14 and 20 June and on the Murman coast in usual years between 19 June and 2 July, and in late years between 3 and 15 July. The other notes are calculated in the same manner as for the Snow Bunting. In Western Taimyr the dates are later; there, complete but early sets are found about 21 June, normal sets between 24 June and 1 July, and the very late sets about 12 July. At the mouth of the Lena River Dr. Bunge found a considerable series of sets, probably normal, between 25 June and 5 July and Matiessen found a complete set but very early, already by 17 June 1903. As to what concerns the latitudes of the Kolyma, Koren found normal sets there on 25 and 26 June 1912, while on the Bolshoi Baranov promontory he discovered a very early set which would have been completed 15 June 1912.

I should preface the detailed description of the nests and eggs of the Lapland Bunting brought home by the Russian Polar Expedition with a few remarks on the position of the nest which differs markedly from that of the Snow Bunting. Quite in contrast to the latter the Lapland Bunting never inhabits rocky places but lives exclusively in the mossy and slightly undulating tundra. Its habit of placing its nest among the hillocks is so noticeable that its name in the Yakut language signifies the "bird of the hillocks." The position of the nest is remarkably well illustrated by the photograph here given (Pl. 22, fig. 2).

1. 24 June 1901, west coast of Taimyr Strait (*Dr. H. Walter*).—This nest, according to the notes furnished by Birula (1907), was placed on a gently sloping hillock in a dry elevated spot of the tundra. The lining of the nest was turned toward the sun and the nest itself protected above in part by the hillock itself and in part by the vegetation which overhung it. The nest itself was placed upon a thin bed of moss which covered the cold water-soaked earth. It is composed of two distinct layers: the outer layer is formed of more solid blades of grass, the inner layer consists of the same but finer material; the lining consists of a considerable number of feathers of the Brant (*Branta bernicla bernicla* (Linné). Its length is 120 mm., its width 111 mm. The lining is very shallow and measures approximately 79 mm. long by 68 mm. wide. The nest contains five fresh eggs of the following dimensions and weights: 20.8 mm. x 15 (15 cg.); 20.1 x 14.5 (15 cg.); 20.3 x 15 (15 cg.); 20 x 14.3 (15 cg.); 20.6 x 15 (15 cg.). The eggs are of a uniform cinnamon-brown tint (Ridgway, Pl. 15) sometimes slightly washed out in appearance so that a

clear ground color appears. Some fine lines and streaks of a dark brownish black are scattered over the surface.

2. 12 July 1901, west coast of Taimyr Strait (Dr. H. Walter).—Five eggs without nest. Dimensions and weights of the eggs: 21.1 mm. x 14.6 (15 eg.); 21.1 x 15 (15.1 eg.); 20 x 14.5 (15.3 eg.); 22.2 x 14 (15.2 eg.); 22 x 14.1 (15.1 eg.). The ground color is of a drab gray (Ridgway, Pl. 46), that of three eggs with a brownish tint; the deeper spots are of a dark brown (Ridgway, Pl. 46, benzo brown). One egg has small zigzag marks of a wood brown (Ridgway, Pl. 40). The superficial spots which ordinarily are concentrated about the large end forming a sort of wreath there, are of a clove brown (Ridgway, Pl. 40). Sometimes the edges of these spots are paler, of a seal brown (Ridgway, Pl. 39).

3. 28 June 1901, west shore of Taimyr Strait (Dr. H. Walter).—This nest is formed of rather large grass blades interwoven with moss and lichens. The lining is of fresher and more delicate grass blades and tufts of hair from the wild reindeer. Its length is 113 mm., its breadth 111 mm.; the length of the cavity is 66 mm., its width 57.5 mm. The nest contained five incubated eggs of the following dimensions and weights: 21 mm. x 15 (15.1 eg.); 21 x 14.8 (15.1 eg.); 21.2 x 15 (15.1 eg.); 21 x 15.1 (15.1 eg.); 20.8 x 15 (15.1 eg.). The ground color of all five eggs is an écru drab (Ridgway, Pl. 46) with a very faint gray-greenish-blue tint; some are rather brightly washed with isabella color (Ridgway, Pl. 30); the spots of the background are of fawn color of different shades (Ridgway, Pl. 40); the superficial spots which are thread-like in shape, sometimes crossing, sometimes zigzag or comma-shaped, are of a clove-brown color (Ridgway, Pl. 40).

4. 19 June 1902, Nerpalach Bay, Kotelny Island (Dr. V. Katin-Jartzeff).—Six eggs without nest. Dimensions and weights of five eggs, the sixth being in a bad state of preservation: 20.1 mm. x 15 (15 eg.); 20 x 14.6 (def.); 20.3 x 15 (15 eg.); 20.2 x 15.3 (16 eg.); 20.6 x 15 (def.). Two of the eggs of this set have a very clear olive-gray background (Ridgway, Pl. 47, light tea green) with deeper spots of drab brown (Ridgway, Pl. 46, drab) and some serpentine lines of a very dark brown, almost black. The four other eggs have a pale-drab ground color with washed-out spots of the same but with a darker clouding and with specks and superficial lines of black. Two of the eggs of this set are incubated; the remaining four are fresh.

5. 23 June 1903, Faddejefski Island (S. Tolstow).—The nest is composed of two layers. The outer layer is formed of grass blades and fine roots of bushes interwoven with tufts of moss and lichens; the inner layer is made of fresher and more delicate grass blades. The lining is of hair from the wild reindeer together with a great number of white feathers of the Willow Grouse; the outer layer is as if doubled with down of the Brant Goose, *Branta bernicla nigricans* (Lawrence). Its length is 113 mm. against 80 mm. in width; the length of the cavity is 63 mm., its breadth 55 mm. The nest contained

five eggs of the following dimensions and weights: 20.2 mm. x 16 (15 cg.); 20.1 x 16 (15.2 cg.); 20.7 x 15.3 (15.1 cg.); 21 x 15.2 (15.1 cg.); 21.1 x 16 (15.3 cg.). The ground color of the eggs is pale greenish (Ridgway, Pl. 41, water green), the washed-out spots of the ground color are partly drab brown (Ridgway, Pl. 46, drab), sometimes buffy brown or even natal brown (Ridgway, Pl. 40). The density of these spots is very different, but sometimes they almost entirely conceal the ground color. The spots and superficial lines are not at all numerous and of a very dark brown, almost black.

6. 15 June 1902, Elijdep promontory, mouth of the Lena (*M. Brusneff*).—This nest is likewise composed of two layers: the outer is formed of dark-colored grass blades of the preceding year interwoven with tufts of moss; the inner layer consists of dry, yellow and more delicate grass blades. The lining is composed of hair of the wild reindeer and feathers of the Brent Goose, *Branta bernicla nigricans* (Lawrence). The nest is so much pressed out of shape that I cannot give the measurements. It contained five eggs of which three can neither be measured nor weighed. The two others have the following measurements and weights: 19.5 mm. x 14.1 (14 cg.); 20 x 14.2 (15 cg.). The ground color of the eggs is a very clear olive green (Ridgway, Pl. 47, tea green); the deeper spots are light drab brown (Ridgway, Pl. 46) and the superficial spots, which form various lines, specks and zigzags, are black with a tendency toward a chestnut color.

7. 17 June 1903, Bykow peninsula, mouth of the Lena (*Th. Matiessen*).—The nest is composed also of two layers: the outer layer is made of grass, interwoven with a relatively large amount of moss; the inner layer is made of finer and fresher grass blades. The lining is furnished with hair from the wild reindeer, white feathers of the Grouse or Ptarmigan and feathers and down of the Brent Goose, *Branta bernicla nigricans* (Lawrence). The nest measures 117.5 mm. in length, 110 mm. in width; the cavity has a length of 70 mm. against 55 mm. in width. The nest contained five eggs, slightly incubated, two of which were broken in preparation. The three remaining have the following dimensions and weights: 21 mm. x 14.8 (15.1 cg.); 21.1 x 15 (def.); 20.2 x 14.8 (15.1 cg.). The ground color of the eggs of this set, of a very pale greenish (Ridgway, Pl. 41, yellowish glaucous), is almost entirely concealed by a series of washed spots of a russet brown (Ridgway, Pl. 29, verona brown) of two shades, the one paler, the other darker; the superficial spots consist of small points gathered in one egg about the large end. These spots are brown of a very dark chestnut tint, almost black.

I have no original notes on the moult of the Lapland Bunting. The young before leaving the tundra gather into small flocks toward the middle of August, and for some while lead a nomadic life. The dates of departure from the region of the Eurasian tundra are very few indeed. On Kolguev Island, according to Trevor-Battye (*l.c.*) in

the second week of September almost all the birds had gone; at the mouth of the Yenisei, at Golchiha, a storm followed by a gale forced all the Buntings to leave the place on 27 August 1914 (Haviland, Ibis, 1915, p. 397); finally Birula informs us that on the Island of New Siberia the advance guard left on 27 or 28 August and that the migration lasted until 9 September 1902. The most northerly point where the Lapland Bunting has been noticed up till now is Cape Flora (80° north latitude) in the Franz Josef archipelago. Jackson (A Thousand Days in the Arctic, vol. 2, app., p. 397, 1899) observed three individuals there.

Calcarius lapponicus alascensis Ridgway.— In 1922, Crawford (Snyder, Univ. of Toronto Studies, biol. ser., no. 28, p. 16, 1926) collected two specimens on Wrangel Island (Sect. XX), which J. H. Riley referred to this form. A young bird brought back by Mr. Amory (Riley, Proc. U. S. Nat. Mus., vol. 54, p. 623, 1918) was secured in Koljuchin Bay (Sect. XXI), on the north coast of the Chuckche peninsula.

ALAUDIDAE.

Alauda arvensis arvensis (Linné).—Two males of this species appeared on the Murman coast (Sect. III) near Yokanga, 4 April 1920 and 12 April 1925, and a female, 25 January 1925 (coll. Kapustin). It is quite evident that this last specimen could not have made the journey to Yokanga passing in January across the snow-fields of entire Russia, but without doubt it came probably from the British Isles, followed the southern branch of the Gulf Stream, doubled the North Cape and travelling along the Murman coast reached finally, on January 25, Yokanga. The two males evidently followed the same course.

6. **Otocorys (=Eremophila) alpestris flava** (Gmelin).

Otocorys alpestris (Linné). WALTER, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 388, 1901. KOLOMEITZEFF, *ibid.*, vol. 15, no. 5, p. 507, 1902. BIRULA, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, **137**, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: young, 14 August 1900, Dickson Bay, mouth of the Yenisei (Dr. H. Walter); adult male, 5 June 1902, Charaulach Mountains, mouth of the Lena (M. Brusneff); adult female, 1 July 1902, mouth of the Elijdep River (M. Brusneff).

According to Oberholser's monograph (Proc. U. S. Nat. Mus., vol. 24, p. 810, 1902) the palaearctic polar form of the genus *Otocorys* (= *Eremophila*) belongs to the subspecies described by Gmelin under the name of *Alauda flava*. The specimens brought back by the Russian Polar Expedition are in no wise different from our European examples; the tints of their coloration are quite as pale, particularly the yellow wash on the throat, which may be sufficiently explained by the time of year in which they were captured when their plumage was already much worn. *Otocorys alpestris flava* (Gmelin) by no means inhabits the Eurasian tundra throughout its whole extent but is distributed in a very peculiar fashion there. First, it is entirely lacking in Spitzbergen (Sect. I) and on Bear Island (Sect. II) but is found on Kolguev Island (Sect. V), Vaigach Island (Sect. VII), the two islands of Nova Zembla (Sect. VIII), and has even been recorded, 9 June 1897, at Cape Flora in the Franz Josef archipelago (Sect. IX), that is to say, at a

latitude of almost 80° north, by the Jackson Expedition (A Thousand Days in the Arctic, vol. 2, app., p. 399, 1899). Next, it inhabits all the coast of the Arctic Ocean from the Kola peninsula to the mouth of the Yenisei (Sect. III, IV, VI, X, XI) where Dr. Walter of the Russian Polar Expedition collected a young bird in Dickson Bay, 14 August 1900 and Naval Lieutenant Kolomeitzeff (*l.c.*) observed this species in 1901. In all the outstanding portion of the tundra which covers the Taimyr peninsula (Sect. XII, XIII) the Horned Lark has not been reported either by the Academician Middendorff in 1843 or by members of the Russian Polar Expedition but it reappears at the mouth of the Lena River (Sect. XIV) whence come two adult specimens taken by Brusneff, 5 June 1902, in the Charaulach Mountains and 1 July 1902, at the mouth of the Elijdep River. On all the islands adjacent to the Siberian coast of the Arctic Ocean as well as in the islands of the New Siberian archipelago (Sect. XVI), the De Long group (Sect. XVII), Wrangel and Herald Islands (Sect. XX), *Otocorys* is not found. Since I have been unable to obtain exact data either as to the length of incubation period of this bird or of the time between the hatching of the young and the moment when they leave the nest, I must omit giving a table of the propagation of this species and will limit myself to listing the dates which I have at my disposal. Goebel (Ornith. Jahrb., vol. 12, p. 213, 1901) has given the following notes on the arrival of the Horned Lark in Yeretiki Bay on the Murman coast (Sect. III) to the west of Kola Bay: 14 May 1882, 24 May 1884, 4 May 1896, 29 May 1899, 23 May 1900, 14 May 1901; and Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 41) observed its arrival on Matochkin-shar of Nova Zembla (Sect. VIII), on 22 May 1903. As to its departure from the latitudes of the Eurasian tundra we find dates for Nova Zembla in Bilkiewicz (App. Scient. Results Exped. Univ. of Kasan, p. 26, 1904 (in Russian)) according to which he observed the last good-sized flocks of *Otocorys* 27 September and Schaanning (*l.c.*) noted the last birds at Matochkin-shar, October 1902. Haviland (Ibis, 1915, p. 396) observed the departure of the last *Otocorys* from Golchiha at the mouth of the Yenisei (Sect. XI) 10 August 1914. As to the period of propagation, three explorers of the polar regions, Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 313, 1912), Pearson (Ibis, 1898, p. 194), and Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 41) affirm (the two first relying on the reports of the Samoyedes) that the Horned Lark has two broods a year. It appears that the observations of Pearson in Nova Zembla confirmed this statement since this naturalist has recorded that by 24 July young birds were already on the wing and that he found on the same day a nest with a single fresh egg, probably of a second brood. Between 24 July and the middle of September, given by Bilkiewicz (*l.c.*) as the time of departure from Nova Zembla for the bulk of the Horned Larks, they have sufficient time for a second brood. The observations of Schaanning are still more convincing. This naturalist records, on the one

hand, the laying of the first egg 15 June 1903, this set being therefore completed about 19 June 1903; on the other hand he observed young birds which had already left their nests on 10 July 1903. The parents of these young ones must then have had sufficient time to produce the second set and indeed he found between 15 and 17 July nests which contained but a single egg and which must, therefore, have held complete sets between 19 and 21 July. Furthermore he recorded also later sets in which the first eggs were not laid until 24 and 30 June. These sets could not have been completed before 28 June and 4 July, and contained newly hatched young about 12 July. The parents of these sets had evidently been prevented from laying a second time. According to Mr. Gorbunow (*in litt.*) flying young birds were observed in Puchovaja Bay 16 August 1923, whereas in 1925 in the Belushja Bay 5 August the parent birds were anxious to lead the naturalist from their nest (probably a second brood). Specimens of adult birds taken on 5 September 1924 were moulting.

On Kolguev Island (Sect. V) the first nest with four eggs was found by Trevor-Battye (Icebound on Kolguev, p. 421, 1895) on 27 June; on Vaigach Island Pearson (*l.c.*) collected four nests with their eggs between 30 June and 11 July. In Nova Zembla (Sect. VIII) Smirnow (Nature and Hunting, 1903, no. 8, p. 46 (in Russian)) found a set of five fresh eggs 4 June 1901 and Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 313, 1908) found a nest with five young 25 July. Pearson's notes have already been cited above. Finally, between 3 and 5 June the Horned Larks according to Zitkow began to lay their eggs on the Yamal peninsula (Sect. X). The most northerly point from which the Horned Lark is yet known is Cape Flora in the Franz Josef archipelago at almost 80° north latitude.

In 1914, Thayer and Bangs (Proc. New England Zoöl. Club, vol. 5, p. 43) described a new subspecies of this genus under the name *Otocorys alpestris euroa* found by Koren at Nishni Kolymsk. Not having been able to examine typical specimens of this form I hesitate to pronounce categorically on this subject but nevertheless I admit the possibility that it only represents one of the Siberian races with nearly white throat such as *Otocorys* (=*Eremophila*) *alpestris brandti* (Dresser). In any case this form does not belong to the Siberian tundra and chiefly on this account I hesitate to introduce it into the fauna of this region.

Motacillidae.

Motacilla alba alba Linné.—The common White Wagtail inhabits the southern borders of the Eurasian tundra in the vicinity of human habitations from the Kola peninsula to the mouth of the Yenisei (Sect. III, IV, VI, X and XI) and is lacking on all the adjacent islands with the exception of Kolguev Island (Sect. V). The members of the Russian Polar Expedition did not meet with this bird.

7. **Motacilla alba ocularis** Swinhoe.

List of Specimens from the Russian Polar Expedition.

Skins: male, 19 June 1902, mouth of the Elijdep River, mouth of the Lena; also young (M. Brusneff). *Nest and eggs:* nest with six eggs, 19 June 1902, same place and collector.

This form of the White Wagtail evidently replaces the ordinary form along the southern limits of the Siberian tundra from the Yenisei River as far as Bering Strait. In the Yenisei region (Sect. XI) it has been noted as far north as 72° by Tugarinow (Mat. on Birds of gov. Yeniseik, p. 55, 1911 (in Russian)), on the Taimyr River (Sect. XII) by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 166, 1853, under *Motacilla alba* var. *lugens* Illiger (*lugubris* Pallas)); I have verified the identification from specimens in our Zoölogical Museum. In the latitudes of the Lena River (Sect. XIV) Dr. Bunge has found it and Brusneff of the Russian Polar Expedition, on 19 June 1902, collected a nest with six incubated eggs together with the male bird belonging to this set at the mouth of the Elijdep River. Dr. Bunge brought back from his expedition a single specimen of this species from Great Ljakoff Island (Sect. XVI), the identification of which I have confirmed. Finally it has been observed at the mouth of the Indigirka River (Sect. XVIII) by Sensinow (Zitkow and Sensinow, Journ. Sec. Zoöl., Soc. Friends of Nat. Sci., Anthr., Ethn., new. ser., vol. 3, no. 2, p. 18, 1915 (in Russian)); in the region of the mouth of the Kolyma (Sect. XIX) (notably at Cape Schelagski, Chaun Bay, in 1912 by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 41, 1914; see also Riley, Proc. U. S. Nat. Mus., vol. 54, p. 621, 1918); there are several specimens from the vicinity of the "Vega's" winter-quarters on the northern coast of the Chuckche peninsula (Palmén, Sibir. Ishk. Fogelf., p. 267, 1887), and at Cape Serdze-Kamen while at Irkaipij it was taken in 1912 by Koren (see Thayer and Bangs, 1914).

The adult male taken by Brusneff is perfectly typical and requires no particular comment. The nest is large, solidly built and thick-walled; it is made of dry grass blades of the preceding year interwoven with twigs, sometimes fairly thick, of a small shrub, probably *Betula nana*, and tufts of moss or lichen. The inner layer of the nest is formed of finer grass so arranged that the material becomes finer and finer toward the lining. The cavity itself is abundantly furnished with hair of the wild reindeer very skilfully selected from the finest tufts and in addition a feather of the Snowy Owl (*Nyctea nyctea*). The length of the nest is 198 mm., its width 171 mm.; the cavity measures 64 mm. in length by 56 mm. in width. The six eggs of the set show the following dimensions and weights: 21.2 mm. x 15.1 (18 cg.); 22 x 15.8 (18 cg.); 22 x 15 (18 cg.); 21.2 x 15.1 (17 cg.); 21 x 15 (22 cg.? probably incompletely emptied); 21.5 x 15 (16 cg.). The eggs have a white ground color covered with small spots of a drab brown (Ridgway, Pl.

46, drab) uniformly disposed over the surface and forming a wreath at the large end and a small number of black lines on the large ends of some of the eggs.

The farthest-north point attained in the distribution of this species, according to Middendorff's observations, is 74° north latitude in Taimyr.

Budytes flava flava (Linné).—A pair of the typical form of Yellow Wagtail was found at Yokanga on the Murman coast in the spring of 1920 that was evidently about to breed. Kapustin secured the male on 20 May 1920 and the female, 21 May.

8. **Budytes flava borealis** Sundevall.

List of Specimens from the Russian Polar Expedition.

Skins: adult male, 5 June 1902, Charaulach Mountains, mouth of the Lena (M. Brusneff); adult, 10 June 1901, Michailow Camp, Kotelny Island (O. Cionglinski).

I wholly agree with the opinion expressed by Hartert (Vögel Pal. Fauna, p. 291, 1905) that the presence of traces, sometimes rather extensive, of a white eyebrow in specimens of the Northern Yellow Wagtail are not necessarily sufficient reason for referring such examples to the form designated as *Budytes flava flava* (Linné). It is especially the much darker color of the occiput and of the auricular feathers as well as the presence of olivaceous spots on the breast that furnish characteristic marks of the northern form. The two specimens brought back by the Russian Polar Expedition wholly substantiate these suppositions; one of them has no trace whatever of the white eyebrow stripe while in the other this mark is fairly well developed. For this reason I feel obliged to refer the specimens of Yellow Wagtails, collected by the members of the "Vega" Expedition near the vessel's winter-quarters on the northern coast of the Chuckche peninsula, to the northern form (*Budytes flava borealis* Sundevall) and not to the form *Budytes flava flava* (Linné) as Professor Palmén (Sibir. Ishk. Fogelf., p. 269, 1887) has done. For the same reasons the subspecies *Budytes flava plexus*, described by Thayer and Bangs (Proc. New England Zoöl. Club, vol. 5, p. 41, 1914), should in my opinion be expunged. The Northern Yellow Wagtail inhabits the Murman coasts of the Kola peninsula (Sect. III), the Kanin peninsula (Sect. IV), the mouth of the Yenisei (Sect. XI) as far as 72° north latitude (Popham, Ibis, 1898, p. 499), and the region of the Lena River (Sect. XIV), whence comes a specimen taken by Brusneff; it has been detected likewise on Kotelny Island by Cionglinski (Sect. XVI) and on the northern coast of the Chuckche peninsula (Sect. XXI) by the "Vega" Expedition as well as by Koren (Thayer and Bangs, 1914) and Amory (Riley, 1918). [The generic distinction between *Motacilla* and *Budytes* is here maintained.]

Budytes citreola citreola (Pallas).—The Citrine Wagtail has only been observed in the neighborhood of the southern frontier of the Eurasian tundra on the lower course of the Pechora (Sect. VI), in the Yamal peninsula (Sect. X) and as far north as 72° at the mouth of the Yenisei (Sect. XI). The Russian

Polar Expedition did not meet with this species in the localities visited on the Siberian coast of the Arctic Ocean.

Anthus trivialis hodgsoni Richmond.—The Hydrographic Expedition to the Arctic Ocean brought back three specimens of this Pipit. The first one appeared 4 October 1914, on the transport "Taimyr" in the latitudes of Eastern Taimyr (Sect. XIII) at 76° 45′ north latitude and 100° 30′ east longitude. It was found dead the next day and was preserved by Dr. L. Starokadomski. The two other specimens were captured by Dr. Ed. Arnhold of the transport "Vaigach," the first, 22 September 1914, in the same region, 76° 33′ north latitude and 99° 52′ east longitude at a distance of fifteen leagues from King Oscar Land and the second one, an old female, at 76° 48′ north latitude, 100° 50′ east longitude, on the peninsula of Dick Bay. All three specimens are in our Zoölogical Museum.

Anthus pratensis (Linné).—The Meadow Pipit has been recorded in the latitudes of the subalpine region, bordering the tundra, in the following of our sections: Kola peninsula (Sect. III), Kolguev Island (Sect. V), the mouth of the Pechora (Sect. VI), and doubtfully in the Yamal peninsula (Sect. X).

9. **Anthus cervinus** (Pallas).

Anthus cervinus (Pallas). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 388, 1901; *ibid.*, vol. 16, no. 5, p. 239, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 4, **138**, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult female, 18 April 1901, west shore of Taimyr Strait (Dr. H. Walter); adult female, 23 July 1902, Charaulach River, latitude of the mouth of the Lena (M. Brusneff); naked young one, 23 July 1902, same locality and collector.

Nest and eggs: nest with one egg, 16 June 1902, Elijdep promontory, mouth of the Lena (M. Brusneff).

Anthus cervinus (Pallas) is completely absent from Spitzbergen (Sect. I) and Bear Island (Sect. II). In Russian Lapland (Sect. III) it nests in abundance in the tundra region all along the Murman coast; it is found in the Kanin peninsula (Sect. IV), on Kolguev (Sect. V) and Vaigach (Sect. VII) Islands, in the region of the mouth of the Pechora (Sect. VI), on the southern island of Nova Zembla (Sect. VIII), at the mouth of the Ob and on the Yamal peninsula (Sect. X), at the mouth of the Yenisei (Sect. XI), and it is recorded as far north as 73° (but probably inhabits these latitudes as far as the shores of the Arctic Ocean), in small numbers in the western part of Taimyr (Sect. XII) and at the mouth of the Lena (Sect. XIV); according to Professor Palmén (Sib. Ishafsk. Fogelf., p. 273, 1887) at the mouth of the Kolyma (Sect. XIX) and quite accidentally on the northern coast of the Chuckche peninsula (Sect. XXI). On the islands adjacent to the Siberian coast of the Arctic Ocean this species, so far as the evidence goes, is completely absent. The members of the Russian Polar Expedition met with this bird on Vaigach Island, near Jugor Strait (Birula, 1907), on Kuzkin Island in Dickson Bay (Walter, 1901; Birula, 1907), and in very limited numbers during the summer of 1901 at the wintering grounds of the "Sarja" (Walter, 1902; Birula, 1907); finally Brusneff obtained for us a female and its young one from the Charaulach River and a nest with one egg from Elijdep promontory.

The data on the chief events of the life history of *Anthus cervinus* (Pallas) in the region

of the Eurasian tundra are so very few that it is quite impossible to draw any general conclusions from them. Goebel (Ornith. Jahrb., vol. 12, p. 213, 1901) observed its arrival at Yeretiki, west part of the Murman coast, on the following dates: 27 May 1883, 20 May 1884, 21 May 1899, 21 May 1900; and at Alexandrovsk in Kola Bay, 19 May 1901. Miss Haviland (Ibis, 1915, p. 397) observed its departure from Golchiha at the mouth of the Yenisei about 15 August 1914. Data on the breeding of this species obtained by Goebel on the Murman coast are: Pasvig-elf between 1 June and 20 June, fresh eggs; and between 14 June and 7 July, "fresh eggs, eggs slightly incubated, eggs heavily incubated," a statement which does not permit of fixing with any certainty the exact time for the different stages of incubation and therefore has no value. For Kolguev Island we have the data of Trevor-Battye (Ice-bound on Kolguev, p. 420, 1895), according to which he found a nest with six eggs there, 22 June 1894; and the notes of Pearson (Beyond Petsora Eastward, p. 312, 1899) who collected between 5 and 15 July four nests, two of them with nearly fresh eggs, one with eggs well incubated, and the last with young birds. On Vaigach Island, Pearson (1899) found the eggs heavily incubated between 3 and 13 July, while on Dolgoi Island on 20 July he found young birds on the wing. The nest found by Brusneff, 16 June 1902, on Elijdep promontory contained but a single egg. Since the nesting period of the *Anthus trivialis* is fixed by Raspail (Mém. Soc. Zool. France, vol. 9, p. 185–202, 1896) at 22 days of which 11 are occupied by incubation and 11 in the rearing of the young, we may draw the following tentative conclusions: the set of eggs that only contained a single one on 16 June should reach the total number of the normal set of six on 21 June; the hatching of the young should take place 1 July; the nestlings should obtain half their adult size by 7 July and should leave the nest 12 July. The external layer of the nest is made of dried grasses of the preceding year and a few grass stocks. The inner layer is made of finer and fresher grass blades and the lining contains a few hairs of the wild reindeer and some leaves of *Betula nana*. The nest is 109 mm. long and 88.5 mm. wide; the cavity is round and measures in its two diameters 72 mm. The single egg has the following dimensions and weight: 18 mm. x 14.2 (14 eg.). It is of a drab brown with a cinnamon tint (Ridgway, Pl. 46, cinnamon drab) washed with brown spots of a darker tint (Ridgway, Pl. 46, benzo brown). The farthest-north point reached by *Anthus cervinus* is evidently found at the wintering place of the "Sarja" on the west shore of Taimyr Strait, north latitude 76° 8′ and east longitude 95° 6′.

Anthus spinoletta littoralis (Brehm).—The Swedish Polar Expedition found a Pipit in 1868 in the latitudes of Bear Island (Sect. II). It came aboard the "Severine" and probably belonged to this form (König, Avif. Spitzb., p. 145, 1911). On the shore of the Murman coast (Sect. III) this species regularly breeds but it has not been discovered farther to the eastward.

Anthus spinoletta japonicus Temminck and Schlegel.—I have found two notes in the literature as to the occurrance of a Pipit on the shore of the Siberian Arctic Ocean which probably relate to the eastern

Asiatic form of the *Anthus spinoletta*. Buturlin (Journ. f. Ornith., vol. 56, p. 293, 1908) records *Anthus blakistoni* Swinhoe for the lower course of the Lena River (Sect. XIV), a species inhabiting only central Asia, and Professor Palmén (Sibir. Ishafsk. Fogelf., p. 272, 1887) records that on 10 June 1879, on board the "Vega" at its winter-quarters on the north shore of the Chuckche peninsula (Sect. XXI) a specimen of a Pipit was captured which he determined as *Anthus pensilvanicus* (Latham) which species, according to Seebohm and Dresser, he has identified with *Anthus pratensis japonicus* Temminck and Schlegel. Since according to Hartert (Die Vögel der pal. Fauna, p. 282, 1905) the eastern-Asiatic form of this Pipit described by Temminck and Schlegel from Japan should be considered as a distinct subspecies inhabiting a great part of eastern Asia as far as the lower course of the Lena on the west, I have no hesitation in refering the observations of Buturlin and Palmén to *Anthus spinoletta japonicus* Temminck and Schlegel.

Seiurus noveboracensis (Gmelin).—One specimen, obviously a straggler, of this American species was killed, 14 June 1879, at Chutpa Bay (Sect. XXI) on the northern coast of the Chuckche peninsula and was given to the naturalists of the "Vega" (Palmén, Sibir. Ishafsk. Fogelf., p. 274, 1887).

Dendroica coronata (Linné).—An accidental visitor of this American species was captured, 25 May 1879, at Jinretlen on the northern coast of the Chuckche peninsula (Sect. XXI) not far from the winter-quarters of the "Vega" (Palmén, Sibir. Ishafsk. Fogelf., p. 276, 1887).

Paridae.

Aegithalos caudatus caudatus (Linné).—B. Kapustin obtained a specimen of this Titmouse on 14 October 1923, at Yokanga on the Murman coast (Sect. III).

10. Periparus (=Parus) ater ater (Linné).

Parus ater Linné. Walter, Bull. Acad. Imp. Sci. St. Pétersbourg, vol. 15, no. 4, p. 388, 1901. Toll, *ibid.*, p. 346, 1901.

Periparus ater (Linné). Birula, Mém. Acad. Sci. St. Pétersbourg, cl. phys.-math., ser. 8, vol. 18, no. 2, pp. 2, 3, 147, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: male and female, 24 September 1900, Bay of Wolves, western shore of Taimyr (Dr. H. Walter and A. Birula).

The Russian Polar Expedition met with several of these Titmice in the second half of September on the west coast of the Taimyr peninsula between Middendorff Bay (75° 52′ north latitude, 92° 59′ east longitude) and the Bay of Wolves situated a little farther northward. The discovery of these birds, characteristic of the region of the fir forests, several hundred kilometers beyond the limit of forest growth in a region not only bare of trees but even of bushes, is altogether extraordinary and unexpected. I shall therefore reproduce here the exact facts in the case taken from the diary of Dr. Walter and from the publication of Birula. The 18 September 1900, while the "Sarja" was making futile efforts to pass through the masses of floating ice between the continent and the Nordenskjöld Island, and still some leagues from land, an individual of this species came aboard the ship. For some while it hopped about in the rigging, carefully examining the folds of the sails, and then flew off in the direction of an ice-floe. Two days later, 20 September 1900, the vessel was visited by two individuals and Baron Toll saw a third on shore. The 21 September 1900, Birula saw one and Dr. Walter observed a second at a distance of

nine kilometers from the ship. The following day one of these birds again appeared on shipboard and on 24 September Dr. Walter and Birula succeeded each in obtaining a specimen in the Bay of Wolves and Dr. Walter saw several others besides. Birula is of the opinion that these were the same two individuals that appeared near the ship between 18 and 24 September 1900. But since, on 20 September, three birds were seen and on the 24th Dr. Walter, independently of the two individuals killed, saw several others besides, the opinion of the latter that there had been a relatively larger migration of these birds seems to me much more probable. The collection of Kapustin contains a single specimen that had wandered to Yokanga on the Murman coast (Sect. III) where he killed it, 20 October 1923.

LANIIDAE.

Otomela cristata cristata (Linné).—A specimen of this species of Shrike was found dead on Wrangel Island (Sect. XX) by the Corwin Expedition (Nelson, Cruise of the Corwin, p. 165, 1882). According to the colored plate which accompanies the description, the bird in question is a typical specimen, in the first young plumage, of the species most widely spread in Siberia and described by Linné under the name of *Lanius cristatus* and by Pallas as *Lanius phoenicurus*. I therefore see no reason for identifying it, as Schalow has done (Auk, 1884, p. 291), with *Lanius brachyurus* Pallas (Vögel d. Arktis, p. 259, no. 239, 1904) nor with *Phoneus bucephalus* Temminck and Schlegel. The first of these, *Lanius brachyurus* Pallas, is an apocryphal species which no one of the numerous explorers of the Siberian fauna has ever found again. Professor Bogdanow, out of respect for the works of the celebrated Academician Pallas on the one hand and on account of the complete lack of specimens of this species on the other, has hesitated to unite it with one of the well-known Siberian species of Shrikes with red tails and has only reproduced the original description of Pallas to call the attention of future explorers to this doubtful species. Hartert (Vögel d. pal. Fauna, p. 446, 1907) has identified it with his *Lanius cristatus cristatus* (Linné). The form of Shrike from Japan and the extreme eastern part of Siberia, described by Temminck and Schlegel as *Lanius bucephalus*, does not belong even to the genus *Otomela* and need not be taken into consideration.

MUSCICAPIDAE.

Hedimela atricapilla atricapilla (Linné) (=**Muscicapa hypoleuca** (Pallas)).—A male of this species was killed by Kapustin near Yokanga on the Murman coast (Sect. III) 18 May 1923.

SYLVIIDAE.[1]

Phylloscopus trochilus (Linné).—The Willow Warbler does not regularly go farther north than the northern limit of the subalpine zone but occasionally it appears in the tundra. In this latter region it has been identified on the Murman coast of the Kola peninsula (Sect. III), on the Kanin peninsula (Sect. IV), in the latitudes of the mouth of the Pechora (Sect. VI), on the lower course of the Ob River (Sect. X), and as far as 71° north latitude at the mouth of the Yenisei (Sect. XI). The Russian Polar Expedition did not meet with it.

Phylloscopus (collybita) tristis Blyth.—The Siberian Chiffchaff has been recorded from the lower Pechora (Sect. VI) and at the mouth of the Yenisei (Sect. XI) at Golchiha beyond 71° north latitude, that is to say, into the region devoid of bushes. Under the same conditions it is found, no doubt, on the lower course of the Ob but it has been found there only in the parts belonging to the forest zone.

[1] Dr. Walter observed on 30 August 1900, in Middendorff Bay, a Warbler which he records in one place as *Phylloscopus* sp? (Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 388, 1901) and in his diary as *Sylvia* sp.? Since he did not succeed in obtaining this bird its precise identification is impossible, but the bird in question was probably *Reguloides superciliosus superciliosus* (Gmelin) which has since been found in Eastern Taimyr.

Acanthopneuste (=Phylloscopus) borealis borealis (Blasius).—This species of Warbler nests rather frequently in the subalpine zone of the western portions of the north coast of Kola peninsula, especially in the vicinity of the Varanger Fiord (Sect. III). In the tundra lying between the mouth of the White Sea and the Ural Mountains and in nearly the whole of Arctic Siberia this species has not been found, but it inhabits the more southern parts of the countries named, covered with bushes or trees. On the borders of the Siberian Arctic Ocean it is found at the mouth of the Kolyma (Sect. XIX) and was observed in numberless specimens in spring of 1879, at the winter-quarters of the "Vega," on the northern coast of the Chuckche peninsula (Sect. XXI).

Reguloides superciliosus superciliosus (Gmelin) (=**Phylloscopus humei praemium** Mathews and Iredale).—This Wren has hitherto been known only from the mouth of the Yenisei as far north as the 70th degree of latitude (Sect. XI). The Hydrographic Expedition commanded by Captain Wilkitzky brought back a single young specimen of this species taken 23 September 1914 on the east coast of the Taimyr peninsula, fifteen leagues from 76° 40′ north latitude and 100° 53′ east longitude (Sect. XIII) and preserved by E. Arnhold, surgeon of the transport "Vaigach."

TURDIDAE.

Turdus pilaris Linné.—A stray specimen of the Fieldfare has been recorded from Spitzbergen (Sect. I). It nests regularly in the birch forests that occur between the tundra and the forest zone in the Kola peninsula (Sect. III), in the Kanin peninsula (Sect. IV), in the latitudes of the mouth of the Pechora (Sect. VI), at the mouth of the Ob (Sect. X) and of the Yenisei (Sect. XI) (in this last section, only as far north as latitude 70° 30′).

Turdus iliacus Linné (=**Turdus musicus** Linné, *fide* Hartert).—Dr. Bunge brought back a specimen of the Redwing from Spitzbergen, and 13 July 1921, J. D. Browne found one dead at Cape Wijk, in Dickson Land (Sect. I) (Jourdain, Ibis, 1922, p. 162). Professor König found remains of two individuals at Bear Island (Sect. II). On the Eurasian continent this Thrush frequents the subalpine region, very close to the tundra, from Russian Lapland (Sect. III), through the Kanin peninsula (Sect. IV) and the lower Pechora (Sect. VI) to the mouth of the Yenisei (Sect. XI) under 71° north latitude.

Turdus merula merula Linné.—Professor König collected the remains of a Blackbird at the same place on Bear Island (Sect. II), where he found the remains of the Starling and the Redwing.

Hylocichla minima aliciae (Baird).—Three examples of this species were taken by Dr. Almquist between 1 and 10 June 1897, in the vicinity of the winter-quarters of the "Vega" on the north coast of the Chuckche peninsula (Sect. XXI).

11. **Saxicola (=Oenanthe) oenanthe oenanthe** (Linné).

Saxicola oenanthe (Linné). WALTER, Bull. Acad. Sci. St. Pétersbourg, vol. 5, no. 4, p. 388, 1901. BIRULA, Mém. Acad. Sci. St. Pétersbourg, phys.-math. cl., ser. 8, vol. 18, no. 2, pp. 11, **138**, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: young, 14 August 1900, Dickson Bay, mouth of the Yenisei (Dr. H. Walter); adult and young, 27 August 1902, Bykow peninsula, mouth of the Lena (M. Brusneff).

The specimens of the Wheatear collected by the Russian Polar Expedition belong to the typical form and are in no wise referable to the robust Greenland form, *Oenanthe oenanthe leucorrhoa* (Gmelin), recorded from Spitzbergen (Sect. I). On Bear Island (Sect. II), up to the present, the Wheatear has not been observed. The northern limit of distribution for the typical form runs along the Murman coast of Russian Lapland (Sect. III) and includes the Kanin peninsula (Sect. IV), Kolguev (Sect. V) and Vaigach Islands (Sect. VII), the mouth of the Pechora (Sect. VI), the mouth of the Ob (Sect. X) and the mouth of

the Yenisei (Sect. XI) at 73° 50′ north latitude. A pair of these birds was noted, 22 June 1924, in the latitude of the Matochkin-shar, Nova Zembla (Sect. VIII) about the telegraph station (communication of Mr. Tolmacheff). The oviduct of the female contained eggs so well developed that this pair was without doubt about to breed there.

A young bird was secured by Birula (1907) 14 August 1900, at Kuzkin Island, opposite Dickson Bay (Sect. XI). At the first wintering place of the "Sarja" the Russian Polar Expedition did not observe the Wheatear, but Middendorff (Sibir. Reise, vol. 2, pt. 2, pl. 174, 1853) found it between 73° 15′ and 75° north latitude on the Taimyr River (Sect. XIII) and the Hydrographic Expedition to the Arctic Ocean brought back from the same peninsula a set of five eggs taken at the wintering place of that expedition at latitude 76° 40′ north and longitude 100° 50′ east (Sect. XIII). Farther to the eastward the Wheatear has been found by Brusneff 27 August 1902, in the Bykow peninsula at the mouth of the Lena (Sect. XIV) and by Dr. Bunge on the lower Yana as far as 70° north latitude (Sect. XV) and on the Ljakoff Islands (Sect. XVI). A single individual was seen, 9 June 1902, by Birula (1907) on the Island of New Siberia. Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 38, 1914) noted that the Wheatear was generally though sparingly distributed along the northern coast of Siberia from the mouth of the Kolyma (Sect. XIX) to Bering Strait (Sect. XXI). Amory brought back from his expedition two immature males, the first from Ajan Island, Chaun Bay (Sect. XXI), the second from Cape Bolshoi Baranow (Sect. XIX) (Riley, 1918, p. 619). At the winter-quarters of the "Vega" (north coast of the Chuckche peninsula, Sect. XXI) this species appeared in 1879 in fairly large numbers after 31 May but disappeared altogether after 27 June.

So few are the migration and nesting dates for the Wheatear in these northern latitudes that they do not suffice for drawing any conclusions. Goebel (Ornith. Jahrb., vol. 12, p. 213, 1901) noted its appearance at Yeretiki in Russian Lapland on the following dates: 30 May 1883, 31 May 1884, 31 May 1899, 24 May 1900, and 15 May 1901. Koren (*l.c.*) on 6 July 1912, found on Cape Bolshoi Baranow (Sect. XIX) a nest of this bird containing young a week old. According to Middendorff (1853), the last individuals had left Taimyr by 17 August 1843, and Miss Haviland (Ibis, 1915, p. 397) noted the departure of the last birds from Golchiha, 20 August 1914.

Saxicola (=Oenanthe) oenanthe leucorrhoa (Gmelin).—Professor König (Avif. Spitzb., 1911), who obtained four specimens of the Wheatear from Spitzbergen, was the first to show that this group of islands is inhabited not by the typical form, but by the larger Greenland race. It is quite possible that the single Wheatear which, on 12 May 1910 under latitude 74° 50′ north and longitude 11° 43′ east, came aboard the vessel carrying Münsterhjelm (Öfv. Finska Vet. Soc. Förh., vol. 53, p. 20, 1910) belonged also to the Greenland race.

Cyanecula (=Luscinia) svecica svecica (Linné).—The Lapland Bluethroat inhabits the willow

thickets of the subalpine zone and occasionally goes beyond the northern limit of that zone. It has been noted from the Murman coast (Sect. III) to the mouth of the Yenisei (Sect. XI), where it was found by Tugarinow (Mat. Birds of gov. Yenisseisk, p. 21, 1911 (in Russian)) as far north as latitude 72° 15′. A specimen of the Bluethroat was taken by Colonel Feilden (Markham, A Polar Reconnaissance, being the Voyage of the "Isbjörn," p. 333, 1881) aboard the vessel at 70° 6′ north latitude and 48° 40′ east longitude between Kolguev Island and Nova Zembla and was identified as *Ruticilla wolfi;* but I am quite convinced that in this case it was a Swedish Bluethroat. Two other specimens were taken on board the ship "Pomor" the 19th and 26th of June respectively in the latitudes of Kolguev Island (Smirnow, Ornith. Jahrb., vol. 12, p. 251, 1901).

Cyanecula (=**Luscinia**) **svecica robusta** Buturlin.—The Lapland Bluethroat is replaced in the north part of eastern Siberia by a very closely allied but sufficiently distinct subspecies. Buturlin records it for the lower course of the Lena (Sect. XIV) and it was probably this form that was taken by Dr. Almquist, 7 June 1897, at the winter-quarters of the "Vega" (north of the Chuckche peninsula, Sect. XXI).

Phoenicurus phoenicurus phoenicurus (Linné).—A male of this species was found 18 May 1923, at Yokanga, Murman coast, by B. Kapustin.

Hirundinidae.

Hirundo rustica rustica Linné.—The occurrence of Swallows in high latitudes cannot be doubted, but such instances obviously must be few and altogether accidental. Swallows have been twice observed in Spitzbergen (Sect. I) but no specimens were secured and exact identification is thus not possible. This species appears also, though in very restricted numbers and quite accidentally, among the human habitations of the northern part of Russian Lapland (Sect. III); at Yokanga on the Murman coast (Sect. III) Kapustin obtained a male 7 July 1917 and a female 27 May 1920. In 1883, a Swallow was observed by Kriwoscheja (1884) on Nova Zembla (Sect. VIII) and according to Goebel (1879; Smirnow, 1903; Uchtomski, Nova Zembla, p. 32, 1883 (in Russian)), another one on 9 June 1877, came to Captain Tjagin's hut, to die there for lack of food. Buturlin (Zitkow and Buturlin, In the North of Russia, p. 175, 1901 (in Russian)) saw a *Hirundo rustica rustica* Linné at Matochkin-shar. In July 1870, Captain Ulve came upon a pair of Swallows in the vicinity of Cape Nassau (northwest part of North Island) and Gillett saw Swallows 22 July 1870, at 76° 10′ north latitude (Heuglin, Reisen nach dem Nordpolarmeer, vol. 3, p. 87–88, 1874). Finally in the Franz Josef archipelago (Sect. IX) Jackson (A Thousand Days in the Arctic, p. 399, 1899) wounded a bird, 27 May 1896, at Cape Flora, that two of his companions identified as the Common Swallow.

I may here call the reader's attention to the fact that since no example of the Swallow has been recorded along the entire length of the coast of the Eurasian mainland, from the White Sea to Bering Strait, the most northern points attained by this species are found only in those districts of Spitzbergen, the Kola peninsula, and Nova Zembla, that are influenced by the Gulf Stream.

Chelidon (=**Delichon**) **urbica urbica** (Linné).—A specimen of the House Martin was killed 27 June, on the steamer "Pomor" near Kolguev Island (Smirnow, Ornith. Jahrb., 1901, p. 208, and 1902–03).

Cotyle (=**Riparia**) **riparia ijimae** (Lönnberg).—Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 36, 1914) saw, among the islands at the mouth of the Kolyma (Sect. XIX), representatives of the genus *Cotyle* (=*Riparia*) that he regarded as belonging to the Japanese form.

CORACIIFORMES.

Coraciidae.

Coracias garrulus garrulus Linné.—According to Schaanning (Dansk. Ornith. Foren. Tidskr., vol. 10, p. 154, 1916) a Roller was picked up dead by a Samoyede, 31 March 1903, between Belushja Bay and Karmakuly, south island of Nova Zembla (Sect. VIII). The same author records a second found dead in 1921, at Matochkin-shar, Nova Zembla (Sect. VIII). Both specimens are preserved in the Christiania Museum.

CYPSELIDAE.

Cypselus (=Apus) apus apus (Linné).—Four examples of the Swift have been recorded in the regions under consideration. One was captured in Spitzbergen (Sect. I) and the specimen deposited in the Tromsö Museum; a second was noted by Smirnow, 15 June, on board the vessel "Pomor" in the latitudes of Kolguev Island (Sect. V) (the specimen is in our Zoölogical Museum); a third was taken 25 August 1922, at Cape Swjatoi Nos, Murman coast (Sect. III) (Kapustin collection); and a fourth was captured on a vessel between Nova Zembla (Sect. VIII) and the Franz Josef archipelago (Sect. IX) (Jordans, Journ. f. Ornith., vol. 73, p. 448, 1925).

UPUPIDAE.

Upupa epops epops Linné.—A specimen of the Hoopoe has been taken in Spitzbergen (Sect. I).

PICIDAE.

Dryobates leuconotus leuconotus (Bechstein).—A Woodpecker, which could not be secured but which according to Smirnow (Ornith. Jahrb., vol. 12, p. 210, 1901) belonged probably to this species, or might also have been a *Dryobates major* (Linné), was seen, 19 August, on board the vessel "Pomor" at a hundred leagues from Cape Kanin (Sect. IV).

STRIGIDAE.

12. **Nyctea nyctea** (Linné).

(Pl. 23, fig. 1; Pl. 33).

Nyctea nyctea (Linné). WALTER, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 388, 1901; *ibid.*, vol. 16, no. 5, p. 239, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902. BIRULA, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1–4, 7, 10, 17–19, 135, 1907. TOLL, Die russ. Polarf. d. "Sarja," pp. 560, 566, 1909.

Owl. BRUSNEFF, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 181, 1904. KATIN-JARTZEFF, God's World, no. 3, p. 136, 1904 (in Russian).

List of Specimens from the Russian Polar Expedition.

Skins: adult, 12 June 1902, Elijdep promontory, mouth of the Lena River (Brusneff); adult, 23 August 1902, Bykow peninsula, mouth of the Lena River (M. Brusneff); two young in down, 27 June 1902, Besborodovka River, Kotelny Island (Dr. V. Katin-Jartzeff); seven young in down, 5 July 1902, Kotelny Island (Dr. V. Katin-Jartzeff).

In alcohol: one embryo, 20 June 1902, Kotelny Island (Dr. V. Katin-Jartzeff).

Eggs: five (of ten), 26 June 1902, Ogrin peninsula, Kotelny Island; nine (of ten), 20 June 1902, Kotelny Island; three (of eight), 28 June 1902, Besborodovka River, Kotelny Island; six (of eight), 19 June 1902 (collected by Lieut. A. Kolchak); one (of seven), 19 June 1902 (collected by Lieut. A. Kolchak)—(all from Dr. V. Katin-Jartzeff); two, 9 June 1903, Faddejefski Island (S. Tolstow).

Local names: in Russian, *sovà* (Birula); in Samoyede, *hai-ncb-tschu* (Trevor-Battye); in Nova Zembla, *hanim-cho* (Gorbunow); in Yakut, at the mouth of the Lena, *sal gödoï* (Bunge), *kantschala* (Birula) or *hapchala* (Brusneff); in Tunguse, *hacla* (Birula); in Chuckche, *takkadlej* (Palmén).

I must commence my account of the Snowy Owl with a slightly more detailed review of the data on its distribution in the Eurasian tundra, and especially of the places where its nesting takes place. The Snowy Owl is beyond doubt one of the most typical and central figures in the avifauna of the tundra and it has been recorded in almost every one of the sections of the region we are considering. But before discussing the conditions

under which it inhabits the various parts of the Eurasian tundra, I must forever revoke the supposition that it only breeds in those regions that are abundantly peopled by lemmings (*Lemmus* and *Dicrostonyx*). No doubt these little rodents play a very large part in the life of the Snowy Owl and, when present in sufficient numbers, form its principal food, especially in raising its young. But recent observations by a number of explorers of the arctic regions have shown not only that the Snowy Owl does not feed exclusively on these rodents but also that it successfully pursues birds as well. In Spitzbergen, where lemmings are largely absent, it feeds upon Ptarmigan and Little Auks according to Professor König (Avif. Spitzb., p. 140, 1911). Birula (1907) noted the same thing in the New Siberian archipelago, where at all seasons of the year he found remains of Willow Grouse eaten by the Snowy Owl, and once also, remains of a Mandt's Guillemot. I am therefore quite persuaded that in the parts of the Eurasian tundra where the Snowy Owl has not yet been found to breed, either the observations are still insufficient and will be completed by exact data on nidification in these regions, or there are other reasons than the lack of lemmings because of which this Owl does not readily nest in those parts of the tundra.

The Snowy Owl during its breeding season inhabits the alpine zone exclusively, that is to say, those parts that are quite bare of any vegetation whatever, either the tops of the mountains (the *tunturi* of Lapland and the Pae-choi) or the plains of the circumpolar tundra. I believe, therefore, that if these plains are quite lacking in dry hillocks or if they chiefly consist of marshy ground, the Snowy Owl does not readily breed in them and seeks more favorable situations for nesting. Evidently these hillocks are absolutely essential for the existence of this bird because they serve it as observation-posts over its hunting grounds. For hours at a time the Owls remain quietly perched on the summits of these hillocks, and at a distance look like patches of snow; they likewise make their nests on such hilltops of various origin. It is thus very likely that the lack of hillocks in certain parts of the Eurasian tundra, and not the lack of food, is what causes the Snowy Owls to avoid certain regions as breeding places. In Spitzbergen (Sect. I) the Snowy Owl has been noted, according to Professor König (1911) some fifteen times, but no nest has ever been found there. In Birula's paper (Annuaire Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 15, p. 201, 1910) we find an indefinite record of a possible discovery of a nest of the Snowy Owl in Spitzbergen. In the course of an excursion to the south of Horn Sound near Hedgehog Glacier, Birula found, 30 June, on a prominent hilltop a large nest of the previous year that contained small fragments of large white eggs. Birula was unable to decide whether this nest was that of a Goose (*Melanonyx brachyrhynchus* (Baillon)) or of a Snowy Owl, but supposed that it belonged rather to the latter.

For my part, I should not be at all surprised if later investigations should prove that

the Snowy Owl nests not at all or only very rarely in the southern and western parts of the archipelago chiefly visited by explorers, but that it is restricted in its breeding—just as its chief food species, the Ptarmigan, is restricted,—to the northern and eastern parts, which hitherto have been only imperfectly explored.

On Bear Island (Sect. II) the Snowy Owl has not been recorded; but in Lapland (Russian, Finnish and Swedish) (Sect. III) it nests regularly on the summits (*tunturi*) of the mountains and at sea level in the alpine zone, along the Murman coast.

Those who have explored the avifauna of the Kanin peninsula (Sect. IV) have not yet observed the Snowy Owl there, but our Zoölogical Museum possesses an egg of this Owl, collected by Goebel while he was stationed at Archangel, and according to its label, coming from the Kanin peninsula. On Kolguev Island (Sect. V), Zitkow and Buturlin did not find the Snowy Owl at all, while Pearson, Fedosow (1926) and Trevor-Battye did record it, but the last explorer insists that it does not breed there and that the native Samoyedes have never found its nest. On the lower Pechora (Sect. VI) and in the Paechoi Mountains (Sect. X) it has been found to breed. On Vaigach Island (Sect. VII) it is not rare nevertheless, but its nest has never been found there. The statement of Schalow (Fauna d. Arktis, p. 232, 1904) that the Snowy Owl has been observed in Nova Zembla (Sect. VIII) by a number of explorers, who, however, have not succeeded in discovering nests, should be corrected in the sense that the bird doubtless breeds on this double island and at times abundantly, because the Russian explorers Nossilow and Borissow have brought back from Nova Zembla eggs of this species which are now in our Zoölogical Museum. Finally, Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 49) tells us that while in 1902 he had not the good fortune to find any sign of the nesting of the Snowy Owl and did not observe the first bird until 18 December 1902, he was successful in finding in 1903, in the region of the Matochkin-shar at least thirty sets of eggs or young birds. I agree, however, in admitting the possibility that the real majority of the Snowy Owls retire sometimes to nest in the almost wholly unexplored lands of the northern parts of the North Island. I base this opinion on the fact that in Siberia the Snowy Owl nests in very much greater abundance on the islands that form the archipelago of New Siberia, than on the continent. This is quite in accord with observations made in America: there the Snowy Owl is known to breed almost as far north as the 83d parallel of latitude (Grinnell Land) and Reinhardt (Schalow, Die Fauna d. Arktis, p. 232, 1904) expresses the opinion that it nests chiefly in the northern portions of Greenland. In the Franz Josef archipelago (Sect. IX) it is occasionally observed, and I am confident that Dr. Bruce is right in admitting that the Snowy Owl nests there at times. That would of course be the most northern point for the breeding of this Owl in the palaearctic region, but falls far short of being its most northern latitude in the nearctic region. In the portions of the Eurasian

tundra situated along the Siberian coast of the Arctic Ocean (Sect. X–XV, XVII), from the Yamal peninsula to the lower course of the Indigirka, the Snowy Owl is not rare and breeds generally. Then it is very abundant on most of the islands of the New Siberian archipelago whence the Russian Polar Expedition brought back a considerable series of sets of eggs and young birds, which are of exceptional scientific interest. At the mouth of the Kolyma (Sect. XIX) the Snowy Owl has been noted all along the coast of the Arctic Ocean by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 35, 1914). This same observer reports that here as well as along the northern coast of the Chuckche peninsula it avoids the marshy areas. It has not been recorded from Bennett Island (Sect. XVII). On Wrangel Island (Sect. XX), Nelson (Cruise of the Corwin, p. 76, 1883) and Rosse (Journ. Amer. Geogr. Soc., vol. 15, p. 171, 1883) have observed it and on the northern coast of the Chuckche country (Sect. XXI) the naturalists of the "Vega" Expedition, as well as Koren (Thayer and Bangs, 1914), found it in rather large numbers and brought back specimens of the birds and eggs from the region of the "Vega's" winter-quarters in 1879.

As to the places where the Snowy Owl was observed by the members of the Russian Polar Expedition, I should first mention Dickson Bay (Sect. XI), where Dr. H. Walter (*in litt.*) noted one 15 August 1900. In the latitudes of Western Taimyr (Sect. XII) in the vicinity of the "Sarja's" first winter-quarters, the Arctic Owl appeared from time to time but no nest was found there and it was only during an excursion to the Taimyr River that Dr. Walter (1901) and Birula (1907) observed, 6 August 1901, a rather large number of young birds. The auxiliary expeditions have secured data on the Snowy Owl from the mouth of the Lena (Sect. XIV) where it was found by Brusneff, (1904; *et in litt.*) in the Charaulach Mountains and at Cape Elijdep, and observed nesting in 1902 on the hilltops of the Bykow peninsula. During his journey in 1903 to Bennett Island in search of Baron Toll, Lieutenant A. Kolchak (*in litt.*) noted the Snowy Owl between 25 April and 5 May between Kasachje and Tiksi Bay; on 31 May on the northeast coast of Little Ljakoff Island; and in autumn until 25 September in the vicinity of Camp Michailow, Kotelny Island. The same traveler, in early June 1903, found an abundance of Snowy Owls nesting in the neighborhood of Cape Medweshi on Kotelny Island (Sect. XVI).

On Bielkovski Island, Kolchak found, 22 May 1902, evidence of the Snowy Owl's presence but was not himself able to see the bird there. On Kotelny Island this Owl nests in considerable numbers, particularly in those parts covered by Devonian and Silurian strata. In 1902, during the Expedition's stay at Nerpalach, nests were discovered on the Ogrin peninsula and along the shores of the Besborodovski River (Dr. Katin-Jartzeff, *in litt.* and specimens taken). On one excursion Lieutenant Kolchak

noted this bird on the Balyktach and Yelissejeff Rivers and on 19 June found two nests. In the spring of the same year Lieutenant Matiessen saw a Snowy Owl in the northern part of Bunge Land and the ship's Quartermaster saw another on 25 April near Nerpalach (Toll, 1909). While staying at the Island of New Siberia in the summer of 1902 Birula (1907) saw nothing of this species until 3 September when the first ones appeared, but Brusneff found them during the following summer. Finally on Faddejefski Island, S. Tolstow (*in litt.* and specimens) found it during the summer of 1903 and collected eggs there.

In the autumn the greater part of the Snowy Owls forsake their breeding grounds for more southern latitudes. These migrations vary greatly in extent in different years. One may suppose that in the less cold years and years with a less depth of snow the Snowy Owls do not make such extended journeys from their breeding grounds. On the other hand in cold years with heavy snowfall they go very far and have appeared sometimes in Europe, as far south as Holland, Belgium, northern Germany, central and eastern Russia, and in Asia in the southern parts of Siberia, in Turkestan and Mongolia. But these migratory movements do not in any way preclude Snowy Owls from passing the entire winter now and then at very high latitudes. Having proved the presence of the Grouse during the winter in the New Siberian archipelago, Birula admits the possibility of the Snowy Owl wintering there. Zitkow and Buturlin (In the North of Russia, p. 169, 1901 (in Russian)) have brought together the notes of the priest Dosifej and the Assistant Surgeon Winogradow, who spent several winters in Nova Zembla; these notes show that the Snowy Owls do occasionally winter there. Notes on the first arrivals of this bird in spring at high latitudes are very few indeed and do not permit of drawing general conclusions. In Nova Zembla according to Schaanning (1907) the first one (evidently a wintering bird) was observed 18 December 1902, and they became commoner in the months of February and March. For the Franz Josef archipelago we have at our disposal the observations made by Leigh Smith during his winter stay in 1882, according to which the first three were noted respectively on 8, 16 and 19 February (Markham, 1883). During Jackson's sojourn in this archipelago (A Thousand Days in the Arctic, p. 399, 1899) the first Snowy Owls appeared at Cape Flora, 8 February 1896, but it was not till 29 and 30 May that they reappeared in 1897. While the "Sarja" was in winter-quarters on the west coast of the Taimyr peninsula, Dr. Walter (*in. litt.*) and Birula (1907) saw the first Arctic Owl 17 April 1901. At the second wintering place of the "Sarja," on Kotelny Island, the bird was first seen 11 April 1902, in the northern part of Bunge Land (Birula, 1907; Toll, 1909) and in 1903 by S. Tolstow on 26 March at Faddejefski Island. Dates as to the disappearance of the last Snowy Owls in autumn are still fewer. In the Franz Josef archipelago, the last ones were noted in 1896 by Jackson

(1899) 7 September and on the Island of New Siberia by Birula (1907) 7–8 October 1902.

The data as to the breeding of this Owl, recorded by members of the Russian Polar Expedition, are of unusual scientific interest and wholly confirm the very remarkable observations published by the late Professor R. Collett of Christiania and based on statements of the natives of Swedish Lapland. In his "Remarks on the Ornithology of northern Norway," this Norwegian naturalist writes as follows:

> The Snowy Owl does not regularly lay so many as ten eggs, but during the past year (in 1871) many such cases have been reported, accompanied by the following very interesting details. As in all birds of prey the Snowy Owl does not lay its eggs one after another at brief intervals but over an extended period and at irregular intervals, so that by the time one egg is laid, incubation will already have begun with those laid earlier. This results in the young of the same brood differing in the degree of their individual development. The young one hatched from the first egg should thus be almost completely fledged by the time the last one is hatched. So the young covered with thick down may evidently share in covering the remaining eggs, for the parents are quite busy enough with the care of raising the young which in part are already half grown and require a considerable amount of food.

All the complete sets of eggs of the Snowy Owl brought back by the Russian Polar Expedition comprised, besides fresh eggs, those of various degrees of incubation or young already hatched, and prove completely the accuracy of the observations cited by Professor Collett. But one set, taken by Dr. Katin-Jartzeff, has a quite particular value and serves as a basis for a series of very interesting deductions. This set was found at Kotelny Island, 24 June 1902, and contained two nestlings and eight eggs. It was collected 6 July 1902, and then consisted of nine nestlings of very different sizes and a single egg, from which the young bird was on the point of hatching. During this period of twelve days seven young had thus hatched out, which gives us an average of 41 hours between the time of hatching of each young bird. We are therefore in a position to fix approximately the time of the hatching and the laying of each egg of this set, in view of the fact that the duration of incubation of the eggs of the Snowy Owl has been determined in the aviary of Fontaine (Faune du Luxembourg, oiseaux, p. 46, 1865) as between 30 and 34, with an average of 33 days. Fixing the moment of hatching of the last young one of this set as noon of 6 July, we may make certain deductions. (See table on opposite page.)

From this table we may show that precisely at the moment of hatching of the last young of the set, the first one had reached the age of 396 hours, that is, 15 days and 9 hours. Unfortunately we have not at hand exact data relative to the length of time the young remain in the nest, but evidently the error cannot be great if we express the opinion that the first young of the brood was about half grown by the time the last one had just hatched.

The young of this set, of which seven birds and one egg are preserved in our museum, are all of quite different sizes, for while the newly hatched young hardly exceeds a spar-

No. of egg	Date of laying	Incubation period	Time of hatching	Age of each nestling at noon of 6 July
1	19 May	33 days	21 June 3 a. m.	369 hours = 15 days 9 hrs.
2	20 "	"	22 " 8 p. m.	328 " = 13 " 16 "
3	22 "	"	24 " 1 p. m.	287 " = 11 " 23 "
4	24 "	"	26 " 6 a. m.	246 " = 10 " 6 "
5	25 "	"	27 " 11 p. m.	205 " = 8 " 13 "
6	27 "	"	29 " 4 p. m.	164 " = 6 " 20 "
7	29 "	"	1 July 9 a. m.	123 " = 5 " 3 "
8	31 "	"	3 " 2 a. m.	82 " = 3 " 10 "
9	1 June	"	4 " 7 p. m.	41 " = 1 " 17 "
10	3 "	"	6 " noon	0

row in size, the oldest ones (without wing- or tail-quills) are as big as an adult Short-eared Owl. Half of the younger nestlings of the brood are covered with pure-white down; half the older young are coated with ashy-gray down with vermiculations, while in the two oldest, the white feathers are beginning to appear around the eyes and at the bend of the wings. With the help of our distinguished artist, Mr. B. Watagin of Moscow, I have attempted to reproduce for the reader from Nature the interesting appearance of this strange brood (Pl. 33), which comprises one egg and nine nestlings of different ages and sizes. Of the two oldest I am able also to present a photographic reproduction herewith (Pl. 23, fig. 1), taken some time later. At the same time we have no reason for denying the evidence that the covering of down that the entire brood represents, conserves enough warmth to maintain the vitality of the eggs that are still unhatched and gives the old birds the chance to devote their efforts to providing sufficient food for those already hatched.

According to notes communicated by the members of the Russian Polar Expedition (Dr. Katin-Jartzeff, Brusneff, Kolchak and Tolstow, *in litt.*), all the nests of the Snowy Owl were placed on hilltops (*baidsharaki*) and the eggs were merely laid upon the ground without any attempt at a nest (see illustrations of these hills, Plate 21). In the table following, I have endeavored to calculate the dates for the laying of each egg and for the hatching of each young bird of the three most nearly complete sets and for the brood taken 6 July 1902, on Kotelny Island.

In this table the dates are calculated as follows:

Set No. 1.—The presence of five large embryos in this set only permits the supposition that in three days, or approximately 29 June the first young should hatch; this date is therefore taken as the basis of calculation for the others.

Set No. 2.—The approximate hatching date of the first young one is fixed as 30 June,

Breeding Data of Snowy Owl.

	Set No. 1		Set No. 2		Set No. 3		Brood No. 4	
	Found 26 June, with 5 well-developed embryos and 5 eggs more or less incubated		Found 20 June, with 1 well-developed embryo, 7 more or less incubated and 2 fresh eggs		Found 27 June, with 2 chicks and 6 eggs		Found 6 July, with 9 chicks and 1 egg from which the chick was in the act of hatching	
No. of egg	Time of laying of each egg	Time of hatching of each	Time of laying of each egg	Time of hatching of each	Time of laying of each egg	Time of hatching of each	Time of laying of each egg	Time of hatching of each
		approx.		approx.				
1	27 My	29 Je	28 My	30 Je	24 My	26 Je	19 My	21 Je
2	29 My	1 Jy	30 My	2 Jy	26 My	28 Je	20 My	22 Je
3	31 My	3 Jy	1 Je	4 Jy	27 My	30 Je	22 My	24 Je
4	1 Je	4 Jy	2 Je	5 Jy	29 My	1 Jy	24 My	26 Je
5	3 Je	6 Jy	4 Je	7 Jy	31 My	3 Jy	25 My	27 Je
6	5 Je	8 Jy	6 Je	9 Jy	2 Je	5 Jy	27 My	29 Je
7	6 Je	9 Jy	7 Je	10 Jy	3 Je	6 Jy	29 My	1 Jy
8	8 Je	11 Jy	9 Je	12 Jy	5 Je	7 Jy	31 My	3 Jy
9	10 Je	13 Jy	11 Je	14 Jy	.....	.....	1 Je	4 Jy
10	11 Je	14 Jy	12 Je	15 Jy	.....	.....	3 Je	6 Jy

that is to say, to the date of the discovery of a set in which only one embryo is well developed, I have thought it proper to add ten days in order to arrive at the date of its hatching.

Set No. 3.—The entire calculation rests on the firm basis of the hatching of the second young one 28 June.

Set No. 4.—The calculation is based wholly on the hatching of the last young one 6 July.

From the foregoing data we may draw the following conclusions: (1) egg-laying of the Snowy Owls in the archipelago of New Siberia begins during the fourth week of May, between the 19th and 28th of May; (2) the laying period for a set of ten eggs extends over about fifteen days, which in turn confirms the assumption that the first nestling hatches about the same period before the last; (3) assuming that the average time of incubation is 33 days, the young begin to hatch between 21 and 30 June; (4) the set of eggs is usually ten in number but some sets consist of only seven or eight.

Schaanning (1907) has published some very interesting notes on the breeding of the Snowy Owl in Nova Zembla, where, in 1903, he had occasion to study thirty sets and their broods. Most of his observations correspond completely with the results obtained by the Russian Polar Expedition. The period over which seven eggs were laid is fixed by him also at 12 days, which gives the same average interval of 41 hours between the laying of each two eggs. The incubation period, however, he places at 27 days instead of 33 days as determined under conditions of captivity; but I think this author is mistaken on this point since he himself found in the case of eleven nests that the first egg was laid between the 18th and 22d of May, so that these should hatch, if the incubation period

was 27 days, between 14 and 18 June, whereas he was unable to record the hatching of the first young until 23 June, which indicates that the period of incubation must have been longer.

The first courtship notes of the Snowy Owl were heard in 1903 on 5 April and pairing commenced 13 May; the female began to incubate after laying three or four eggs. In case the eggs are destroyed, these Owls lay a second set. The maximum of eggs laid by the same female in two sets may be as many as fourteen. The number in the first set varies from six to nine, that in the second from five to seven. The records of thirty sets and broods obtained by Schaanning may be grouped in the following manner:

Breeding of Snowy Owl.

No. of Set	1	2	3–4	5–11	12	13–15	16	17	18	19	20	21–22	23	24	25	26	27	28	29	30
Sets	1	1	2	7	1	3	1	1	1	1	1	2	1?	1?	1?	1?	1	1?	1	1?
No. of eggs	7	8	9	7	6	6	6	7	5	5	4	7	8	6	6	8	5	8	8	5
First egg laid	18 My	18 My	18 My	22 My	28 My	3 Je	10 Je	10 Je	13 Je	28 Je	2 Jy		21 My	27 My		23 My	7 Je	29 Je	7 Je	
Last egg laid	28 My	30 My	1 Je	1 Je	6 Je	12 Je	19 Je	20 Je	25 Je	5 Jy	3 Jy		2 Je	5 Je		2 Je	13 Je	10 Jy	19 Je	
First young hatched	20 Je	20 Je	20 Je	24 Je	30 Je	6 Jy	14 Jy	14 Jy	21 Jy	31 Jy	31 Jy	23 Je	24 Je	29 Je	27 Je	25 Je	10 Jy	1 Ag	10 Jy	20 Ja
Last young hatched	30 Je	2 Jy	4 Jy	4 Jy	9 Jy	15 Jy	22 Jy	24 Jy	28 Jy	7 Ag	5 Ag		5 Jy	8 Jy		5 Jy	17 Jy	12 Ag	22 Jy	

[1] For broods 21, 22, 25 and 30, data are wanting as to the number of young hatched, and we are thus unable to fix exactly the moment of hatching of the first and the last young of the brood, as well as the time of laying of the first and the last egg.

[2] According to the original observations, there were, on 9 July, eight young, the oldest of which in this author's estimate was eighteen days and the youngest four days, but since between the laying of each egg there is an average interval of forty-one hours and since Schaanning's observations perfectly substantiate this figure, I am of the opinion that the oldes young could not have been more than sixteen days old and I have made this correction in the table.

[3] If in a set of six the youngest nestling is three days old, the oldest cannot have been hatched more than twelve days.

[4] The brood comprised one egg and seven young, of ages ranging, according to the author, from two to fourteen days. I estimate that if the youngest was only two days old, the oldest of the seven nestlings could not have been more than twelve days old.

[5] The brood found 28 July contained one egg and seven young, from one to seven days old according to the author. If the youngest was only one day old, the oldest of the seven could not have been less than eleven days old.

For the eggs of six sets taken by the Russian Polar Expedition I can give the following data:

1. 26 June 1902, Ogrin Peninsula, Kotelny Island (Dr. V. Katin-Jartzeff).—This nest contained ten eggs, some of them so well advanced in incubation that the embryos were removed from five, and preserved in alcohol. The other five eggs of this set show the following dimensions and weights: 61 mm. x 45 (572 eg.); 59 x 45.2 (560 eg.); 58 x 46 (550 eg.); 58 x 44.6 (550 eg.); 57 x 46 (521 eg.).

2. 20 June 1902, Kotelny Island (Dr. V. Katin-Jartzeff).—This nest contained ten eggs, of which one held a large embryo, seven were at various stages of incubation, and two were unincubated. The nest was situated on the summit of a muddy hillock (*baidsharak*) in a slight depression of the ground and was quite without lining. The eggs have the following dimensions and weights: 57.5 mm. x 44 (555 eg.); 57.2 x 45.6 (547 eg.); 57.7

x 44 (520 cg.); 58.5 x 45 (505 cg.); 58.5 x 44.1 (492 cg.); 57.6 x 44.7 (490 cg.); 58 x 44 (470 cg.); 56 x 43.5 (465 cg.); 57 x 44.5 (455 cg.).

3. 28 June 1902, Besborodovka River, Kotelny Island (*Dr. V. Katin-Jartzeff*).—The nest, situated like the preceding, contained two newly hatched young and six eggs. When it was found, the shell of the egg which the second young bird had just left, was still in the nest; three hours later it was gone. Three of the eggs have the following dimensions and weights: 56 mm. x 47 (585 cg.); 56.5 x 47 (565 cg.); 53.7 x 47.5 (–).

4. 19 June 1902, Kotelny Island, collected by Lieutenant A. Kolchak (*Dr. V. Katin-Jartzeff*).—The nest contained eight eggs, two of which had embryos. The dimensions and weights (of six) are: 58.5 mm. x 47 (642 cg.); 61 x 45.2 (615 cg.); 59 x 45.2 (587 cg.); 58.7 x 44.5 (545 cg.); 58 x 45 (535 cg.); 60 x 44 (530 cg.).

5. 19 June 1902, Kotelny Island, collected by Lieutenant A. Kolchak (*Dr. V. Katin-Jartzeff*).—The nest contained but seven eggs and the set is thus probably incomplete, while the eggs, according to a note of Lieutenant Kolchak, were fresh. The only egg preserved from this set measured: 62 mm. x 46 (627 cg.).

6. 9 June 1903, Faddejefski Island (*S. Tolstow*).—Two sets of eggs were found 9 June 1903, on Faddejefski Island, one of which contained nine eggs heavily incubated and the other seven fresh eggs. Most of these eggs remained at Faddejefski Island and but two have come to us; these measure: 60 mm. x 45.5 (575 cg.); 58.3 x 45 (548 cg.).

All the twenty-six eggs brought back by the Russian Polar Expedition are pure white, of a dull tint. According to their dimensions they may be grouped as follows:

Length.		*Breadth.*	
53.7 mm.	1	43.5 mm.	1
56–56.4	2	44–44.4	5
56.5–56.9	1	44.5–44.9	4
57–57.4	3	45–45.4	7
57.5–57.9	3	45.5–45.9	2
58.–58.7	9	46–46.4	3
59	2	47–47.5	4
60	2		—
61	2		26
62	1		
	26		

The maximum length is thus 62 mm., the minimum 53.7; the greater part have a length of 57–59 mm. The greatest breadth is 47.5 mm., the least 43.5, while the greater part measure from 44 to 45.5 mm. in breadth. One set (No. 3) shows evidence that the abnormal breadth of 47–47.5 mm. is attained at the expense of the length in these eggs, which measure but 56, 56.5 and even 53.7 mm. It is evident that the oviduct of the fe-

male to which this set belonged was of a form specially adapted to produce very broad eggs which at the same time were shorter than usual.

As to the weight of the eggshells the following table shows that in each set the weight is different for each egg. By arranging the eggs of each set according to their weights we have the following:

	Set 1.	*Set 2.*	*Set 3.*	*Set 4.*
1	572 cg.	555 cg.	585 cg.	642 cg.
2	560	547	565	615
3	550	520	. .	587
4	550	505	.	545
5	521	492	.	535
6	.	490	.	530
7	.	470	.	. .
8	.	465	.	. . .
9	.	455	.	. . .

The difference between greatest and least weight of the eggshells is in set No. 1, 51 cg. (572–521, incomplete set); in set No. 2, 100 cg. (555–455); and in set No. 4, 112 cg. (642–530 cg.); the weight of each lighter shell differs from that of the preceding by from 5 to 30 cg. The shells of the fresh eggs are the heaviest; those of the incubated eggs lose their weight in proportion to the degree of incubation, a fact which is readily explained, for the carbonate of lime is only soluble in water charged with carbonic-acid gas, and in proportion as the embryo by its breath impregnates the liquid of the egg, the internal surface of the shell begins to dissolve, producing a decrease in the weight of the eggshell. The sets of eggs brought back by the Russian Polar Expedition give perfectly convincing proof of the fact that in eggs laid at intervals the stage of development of each embryo must be different and that between the lightest weight of shell of the first-laid and longest-incubated egg, and the heaviest weight of the last-laid egg there must be in each set a series of intermediate weights, such as the table shows actually to exist. But we may make a further and very interesting deduction. By the aid of my learned friend, Professor of Chemistry, A. Gorbow, I have the following notes at my disposal as to the amount of carbonic-acid gas that an embryo must exhale in order to dissolve one gram of eggshell. The reaction in dissolving the shell takes place in accordance with the following formula: $Ca(HCO_3)_2 = CaCO_3 + CO_2 + H_2O$. To dissolve 100 grams of $CaCO_3$ would take 22,400 cubic centimeters of CO_2 (temperature 0° and barometer 760 mm.) and for 1 gram (= 100 cg.), 224 cubic centimeters, or nearly a quarter of a liter. Designating the maximum weight of eggshell at the time of laying by *A* and the minimum weight of the same shell at the moment of hatching by *B*, we obtain the formula: $(A-B)\ 2.24$—temp. 0°, bar. 760 mm.—for the amount of cubic centimeters of carbonic-acid gas given off by a Snowy Owl embryo through its allantois before it hatches and begins to take in air through the lungs.

The Franz Josef archipelago is apparently the most northerly point where the Snowy Owl has been noted in the palaearctic region; but in America it goes much to the north of this latitude for it has been found nesting almost to 83° north in Grinnell Land.

Surnia ulula caparoch (Müller).—On 22 May 1879, Lieutenant Brusewitz killed a Hawk Owl at Pitlekaj, the winter-quarters of the "Vega" (northern coast of the Chuckche peninsula, Sect. XXI) which, according to Professor Palmén, belongs to the American form, *Surnia ulula caparoch* (Müller).

13. **Asio accipitrinus** (Pallas) (=**A. flammeus** (Pontoppidan)).

? *Asio accipitrinus* (Pallas). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, cl. phys.-math., vol. 18, no. 2, p. 135, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: male, 8 June 1902, Charaulach Mts., mouth of the Lena (M. Brusneff); female, 23 June 1902, Elijdep promontory, mouth of the Lena (M. Brusneff).

Eggs: six eggs, 23 June 1902, Elijdep promontory, mouth of the Lena (M. Brusneff).

Local name: in Yakut, *mechcherge* (Brusneff, *in litt.*).

The Short-eared Owl nests as far north as the alpine zone, covered with dwarf willows (*Regio alpina a salicum*). This part, which is transitional between the Eurasian tundra, bare of even dwarf shrubs, and the subalpine region (the region of bushy willows, alders and birches), comes very close to the Arctic Ocean in some places, and it is there that this Owl has been observed. Under such conditions it has been noted in small numbers in Russian Lapland (Sect. III), in the Yamal peninsula (Sect. X), at the mouth of the Lena (Sect. XIV), at the mouth of the Indigirka (Sect. XVIII), and, according to Buturlin, at the mouth of the Kolyma (Sect. XIX) under 69° 5′ north latitude (Dresser, Eggs Birds Europe, 1910).

Brusneff, of the Russian Polar Expedition, found the Short-eared Owl in the Charaulach Mountains as well as in the Elijdep promontory, while a Tunguse native reported to Birula that this Owl inhabits the borders of the Omoloj River which empties into Borchaja Bay. The nest of this bird found by Brusneff, 23 June 1902, on the Elijdep promontory contained six perfectly typical eggs of the following dimensions and shell-weights: 39. 8 mm. x 32 (175 cg.); 39 x 31.5 (153 cg.); 40 x 31.5 (152 cg.); 38.2 x 31.1 (144 cg.); 39 x 31.7 (138 cg.); 38.8 x 31.6 (128 cg.). The difference in the weights of the eggshells gives us reason to suspect that the Short-eared Owl also lays its eggs at certain intervals and that the degree of incubation is different in each egg.

ALCIFORMES.

Alcidae.

Fratercula arctica (Linné) and race **glacialis** (=**Fratercula arctica naumanni** Norton).—Of the various parts of the Eurasian Arctic Ocean, the Arctic Puffin inhabits only Spitzbergen (Sect. I), Bear Island (Sect. II), the Murman coast (Sect. III), particularly the islands Ainowski (Hen-öarne in Norwegian), the two islands of Nova Zembla (Sect. VIII), and perhaps the Franz Josef archipelago (Sect. IX).

The Arctic Puffin requires for nesting, places of soft soil, sandy or moss-covered, in which it excavates

deep tunnels to lay its eggs while it nests only in very small numbers in the vicinity of gull rocks (*bazary*) if it finds conditions suitable in such places.

For this reason it is not so very common either on Spitzbergen or on Bear Island or on Nova Zembla, and only nests in any considerable numbers on the Ainowski Islands of the western part of the Murman coast for these afford the sort of breeding ground it requires. At Nova Zembla, according to G. P. Gorbunow (The gull rocks (*bazary*) of Nova Zembla, Mem. Sci. Instit. for Exploration of the North, pt. 26, pp. 20, 21, 36, 1925 (in Russian)) the Puffin does not breed in Malijy-Karmakuly Bay, was found in three pairs on the gull rocks of the Puchowaja Bay and finally is rather abundant in the Bezymiannaja (Nameless) Bay; in the North Island it is recorded on the gull rocks, lying between Cape Pospelow and Cape Solunski, by Russanow (Materials for the Knowledge of Nova Zembla, vol. 2, p. 77, 1911 (in Russian)). In 1925 the same explorer stated the presence of Puffins on 16 August in Archangelski Bay. For the Franz Josef archipelago this species has been recorded according to Schalow (Fauna d. Arktis, p. 121, 1904) by the Austrian expedition under Payer as seen in the archipelago itself, as well as between the latter and Nova Zembla, but these observations have not hitherto been confirmed by later expeditions and should be accepted provisionally. Professor König (Avif. Spitzb., p. 261, 1911), from an examination of a very considerable series of specimens, has already shown that the northern form of the Puffin, described as *Fratercula arctica glacialis* Stephens, differs from the typical form merely in its larger dimensions, while the differences in the shape and color of the beak are subject to much variation and show all transitional stages between the extremes. Furthermore, the *Fratercula arctica glacialis* Stephens, has no separate geographic range, and though it predominates in the north, it is found nevertheless at the same time, although in limited numbers, in the southern and eastern parts in company with the typical form. Thus, Mawrodiadi (Bull. Univ. Warsaw, 1911, pt. 3, p. 5) has recorded its presence among the colony at the Ainowski Islands, and Buturlin (Our Hunting, 1908, pt. 8, p. 49–64, (in Russian)) has identified specimens of the Puffin from Nova Zembla where the northern form predominates, as the typical *Fratercula arctica* (Linné).

Walter (Journ. f. Ornith., vol. 38, p. 237, 1890) is the only one who has had the opportunity of observing and fixing the time of the Puffin's arrival in the Spitzbergen latitudes. On 10–11 May 1889, he noted a considerable number of these birds between the Norwegian coast and Bear Island and on 17–18 May, the first individuals appeared in Horn Sound, Spitzbergen. Egg-laying took place probably in the course of the first half of June, for the eggs taken by Professor König (1911, p. 266) at Spitzbergen 13 and 14 July 1907, were incubated and some of them heavily so. These facts agree completely with those given by Jourdain (Ibis, 1922, p. 178) according to whom eggs taken 9 July 1921 at Cloven Cliff and 17 July 1921 at Anser Island, Spitzbergen, were barely incubated. The incubation period of the Puffin has been determined by Mawrodiadi (*l.c.*) as five weeks and in an incubator by Evans (Ibis, 1891, p. 83) as 36 days. In Nova Zembla, Bilkiewicz (App. to Scient. Results Exped. Univ. of Kasan in 1904, p. 14 (in Russian)) found young in down on 28 July. The Puffins leave the latitudes of Spitzbergen, according to Professor König (1911) in mid-September and the same author states that Cocks (Zool., 1883, p. 488) killed two males 16 September 1882; Birula (Annuaire Mus. Zoöl. St. Pétersbourg, vol. 15, p. 170, 1910) observed solitary individuals in the open sea on 8 September 1899, in the region of Tee Fjord. The crew of the "Fram" noted the presence of Puffins on 12 July 1896, to the north of Spitzbergen in 83° 11′ north latitude (Collett and Nansen, Norw. North Polar Exp., p. 52, 1899). The Russian Polar Expedition did not meet with this bird during its voyage.

Fratercula corniculata (Naumann). — A single specimen of this species was observed in the latitudes of Herald Island (Sect. XX) by Nelson during the voyage of the Corwin (Cruise of the Corwin, p. 115, 1883) and in considerably large numbers along the north coast of the Chuckche peninsula (Sect. XXI), especially in the vicinity of Cape Serdze-Kamen and Cape Wostochny. Captain Palander of the "Vega" met with a Puffin probably of this species on 31 July 1879, between the winter-quarters of his vessel and Bering Strait (Palmén, Sib. Ishk. Fogelf., p. 400, 1887). According to Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 8, 1914), this Puffin nests in considerable numbers

on Koljuchin Island, but does not pass to the westward of this region. The Russian Polar Expedition did not identify this bird in the latitudes visited.

Lunda cirrhata Pallas.—Nelson (Cruise of the Corwin, p. 115, 1883) has recorded the Tufted Puffin from the north coast of the Chukchi peninsula (Sect. XXI) in the region of Capes Wostochny and Serdze-Kamen, and Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 7, 1914) found several pairs breeding on Koljuchin Island. The Russian Polar Expedition did not meet with it.

Uria troille (Linné) and aberr. **lacrymans** (Valenciennes).—The Common Guillemot visits Spitzbergen (Sect. I) only accidentally, for the Prince of Monaco is the only one who has had the good fortune to establish its presence in the archipelago by killing a specimen at the Barentz Islands on 16 August 1898 (see Oustalet, Bull. Mus. d'Hist. Nat., Paris, 1899, p. 305). On Bear Island (Sect. II) and on the *bazary* (gull rocks) of Russian Lapland (Sect. III) this species, and occasionally also the spectacled variety, known by the name of *Uria troille lacrymans* (Valenciennes), nests in more considerable numbers but is less abundant, however, then *Uria lomvia lomvia* (Linné). The nesting of the spectacled variety of the Common Guillemot on the *bazary* of Archangel Bay, in the north island of Nova Zembla (Sect. VIII) was first recorded by B. Russanow (Mater. for Investigation of Nova Zembla, vol. 2, p. 27, 1911 (in Russian)). The recent scientific expedition under R. Samoilowicz, in which Prof. C. Derjugin and G. Gorbunow took part as ornithologists, succeeded in the years 1922 and 1924 in finding on two of the *bazary* of the southern island small colonies of both forms of the Common Guillemot (see Gorbunow, The "bazary" of Nova Zembla, pp. 17, 18, 20, 1925). The first colony is situated at the top of the cliff of the Bazarny Island, in the Little Karmakuly Bay; among 1538 Guillemots killed Gorbunow found 14 *Uria troille* (Linné) and 8 *Uria troille* aberr. *lacrymans* (Valenciennes). The second colony inhabits also only the summit of the Puchowy Island and consists of nearly a hundred birds, whereas the colony of *Uria lomvia lomvia* (Linné) is approximately estimated at 600,000 individuals.

Uria lomvia lomvia (Linné).—The typical form of Brünnich's Guillemot, which is distinguished from the eastern form by its smaller dimensions, inhabits the western portions of the Eurasian Arctic Ocean, but evidently nests only in places where the seashore is rocky. Such *bazary* (or gull rocks) are plentiful in Spitzbergen (Sect. I), on Bear Island (Sect. II), along the Murman coast (Sect. III), on the western coast of Nova Zembla (Sect. VIII) and the Franz Josef archipelago (Sect. IX) and the islands that surround it, while in the latitudes of the Kanin peninsula (Sect. IV), around Kolguev Island (Sect. V), and in the Kara Sea opposite the mouth of the Ob River (Sect. X), it has not been recorded except in small numbers as a wintering bird. It appears that between Nova Zembla and Preobraschenie Island, situated off the east coast of Taimyr (Sect. XIII) colonies of Guillemots are completely lacking and that in the colony found on the latter island, the typical form is replaced by the larger eastern race, which some ornithologists, especially my American colleagues, regard as a distinct subspecies under the name *Uria lomvia arra* (Pallas), while others, as Ogilvie-Grant (in the Catalogue of the Birds of the British Museum, vol. 26, p. 577, 1898), identify it with the typical form.

It is clear that Guillemots leave their breeding grounds in Spitzbergen (Sect. I) as soon as the young have reached full size and remain, in part perhaps, throughout the winter in those portions of the Arctic Ocean about this archipelago, where the sea is free of ice, a view supported at all events by Professor König (Avif. Spitzb., p. 251, 1911). According to this same author, the Guillemots arrive in Spitzbergen throughout the greater part of the month of May, which coincides with the observation of Dr. Bunge (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 308, 1902) that a considerable migration of Guillemots took place in flocks of from twenty to sixty birds, passing Horn Sound, 24 May 1900, at a considerable height in a direction from east-northeast to west-southwest. In Nova Zembla (Sect. VIII) Kriwosheja (Nature and Hunting, no. 11, p. 39, 1884, under *Uria troile* (in Russian)) has recorded the appearance of the Guillemot 4 May 1883 and Schaanning (Dansk. Ornith. For. Tidskr., vol. 10, pp. 150, 168, 1916) at Matochkin-shar 24 May 1903. After the recent observations of Gorbunow (p. 23, 1925) Brünnich's Guillemot arrives on Nova Zembla regularly in June, sometimes in the middle of that

month. In the Franz Josef archipelago (Sect. IX) the "Eira" Expedition in 1882 noted the arrival of Guillemots 9 March (Clarke, Ibis, 1898, p. 270, and Markham, Proc. Roy. Geogr. Soc. London, vol. 5, p. 210, 1883) and in 1895 Dr. Koettlitz (Clarke, 1898) saw them at Cape Flora, 4 April. In 1896, the same observer recorded the first Guillemots 26 March, while Jackson (A Thousand Days in the Arctic, p. 395, 1899) noted their appearance only on 1 April. Finally in 1897, according to Dr. Koettlitz (Clarke, 1898) Guillemots were first seen 20 March and in 1914 arrived according to N. Pinegin (Gorbunow, p. 23, 1925) in great number 14 April.

The period of incubation of the egg is fixed by Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 138, 1900) and by Professor König (1911) at from 30 to 35 days, while the chicks of *Uria troille* hatched out by Evans (Ibis, 1891, p. 83) in an incubator left the egg between the 30th and 33d day and eggs placed under a hen hatched on the 31st day. We may thus allow an average duration of incubation of 32 days. And as the first downy young were seen at Spitzbergen (Sect. I) by Römer and Schaudinn (1900) on 6 July and by Münsterhjelm (Öfv. Finska Vet. Soc. Förhandl., vol. 53, p. 20, 1910) on 7 July 1910, the eggs must have been laid in the two instances between 4 and 6 June, which coincides with the opinion expressed by Professor König (1911) that egg-laying takes place at Spitzbergen at the beginning of June. On Bear Island (Sect. II), according to Professor König (1911) egg-laying takes place about two weeks later, in mid-June, for the eggs taken by König, 30 June 1908, were very heavily incubated and on 16 July 1907, all the young were still very small. However, as an exception, this explorer found eggs still very slightly incubated on 17 July 1907. The time when the young first appear in the sea has been noted for Spitzbergen by Birula (Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 169, 1910) as 25 July 1899 and by Münsterhjelm (1910) as 17 July. For Nova Zembla (Sect. VIII) we have no data at hand as to the time of egg-laying and can only cite the notes of Schaanning (1924) that on 25 June 1921 the Norwegian Expedition found on Sereburiannaja Bay, North Island, two small young in down and five highly incubated eggs, and of Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 308, 1908) according to which most of the young had attained the greater part of their growth by 28 July 1907, while some were still half grown, and the notes of Bilkiewicz (App. to Sci. Results Exp. Univ. of Kasan, p. 15, 1904 (in Russian)) who at the end of July recorded the presence of a considerable number of young birds in the sea. In the Franz Josef archipelago, Neale found eggs only on 26 June 1882. The Jackson-Harmsworth Expedition (Clarke, 1898) found young in down on 11 August and 24 August 1894, and in 1896 had an opportunity to watch the descent of the young birds from the rocks at Cape Flora; between 13 and 24 August of the same year the birds left the summits of the gull rocks, and descending little by little, finally cast themselves into the sea. Those among them that struck on the ground perished.

The Guillemots leave their breeding grounds in Spitzbergen in the second half of August and keep at some distance from shore in the open sea. Thus Birula (1910), on 2 September 1899, was unable to detect a single individual near the seashores of Spitzbergen, but noted solitary birds on 6 September in the ocean surrounding Ice Fjord. The same observation was made by Münsterhjelm (1910) for on 15 August he noted only a few individuals, on 30 August he saw but a single bird while on 30 September he found a very considerable number in the open sea in the latitudes of Spitzbergen. According to Bilkiewicz (1904) the Guillemots leave Nova Zembla in the second part of August and Schaanning saw them (Bergens Mus. Aarb., 1907, no. 8, p. 96) up to 18 November 1902. Gorbunow (1925, p. 32 33) tells us that the departure of the Guillemots from Nova Zembla begins about 20 August and has a duration of nearly three weeks; in 1923 the *bazary* was definitively left by the birds on 12 September and in 1924 on 5 September there were still a few birds on the cliffs. For the Franz Josef archipelago we have at hand the following data: in 1894, Jackson (1899) noted the last eight birds on 23 September; in 1895, Dr. Koettlitz (Clarke, 1898) observed their departure on 14 September and 30 September, and according to Jackson great companies of them left Cape Flora 30 August and 10 September, though single individuals remained there as late as 30 September; finally in 1896 the greater part left 26 August and the rest by 30 August.

The "Fram" Expedition reported the presence of Guillemots, 19 June 1896, as far north as 82° 55′ (Collett and Nansen, Norw. North Polar Exped., p. 52, 1899).

14. **Uria lomvia arra** (Pallas).

Uria. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 203, 1902. Matiessen, *ibid.*, vol. 18, no. 3, p. 72, 1903. Toll, *ibid.*, vol. 20, no. 5, p. 158–160, 1904.

Uria lomvia (Pallas). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 8, **41**, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult female, 22–31 August 1902, "Sarja" Strait, between Kotelny and Bielkovski Islands (Dr. V. Katin-Jartzeff); young bird, same place and collector.

The typical form of Guillemot does not breed farther eastward than Nova Zembla and frequents the Kara Sea in small numbers only, sometimes wintering if it finds areas of the Arctic Ocean free of ice. The first breeding grounds of Guillemots farther east are found on Ujedinenija (Lonely) Island (Sect. XII) and in Nordenskiöld Sea, where the "Vega" Expedition and the Russian Hydrographic Expedition to the Arctic Ocean found, in the latitudes of Eastern Taimyr (Sect. XIII) at Preobraschenie Island, 74° 44′ north latitude, rocks inhabited during the nesting season by a considerable number of Guillemots (Starokadomski, The Discovery of Unknown Land in the Arctic Ocean, p. 28, 1915 (in Russian)). A large colony of Guillemots was observed by the Russian Polar Expedition at Bielkovski Island (Sect. XVI) (Matiessen, 1903, *et in litt.*) and a rather limited number of these birds was seen on the western shores of Kotelny Island, where the formation is of Silurian and Devonian strata. There is perhaps a similar colony on Stolbowoi Island for the "Vega" Expedition (Palmén, Sibir. Ishavsk. Fogelf., p. 386, 1887) met with occasional Guillemots in the seas surrounding that island. Next, considerable colonies of Guillemots are found on the following islands: Bennett (De Long, The Voy. of the "Jeanette," vol. 2, p. 683, 1883; Toll, 1902, 1904, 1909; Kolchak, 1906); Henriette (De Long, 1883); General Wilkitzky (collection received by our Zoöl. Museum from the Hydrogr. Exp. Arct. Ocean) (Sect. XVII); Wrangel and Herald (Sect. XX) (De Long, pp. 340, 348, 1883; Newcomb, 1888); and Koljuchin Island (Sect. XXI) (Thayer and Bangs, 1914). So far as the specimens from these areas show, it is the eastern form, *Uria lomvia arra* (Pallas), that inhabits the localities just named, from Preobraschenie Island, eastward. If Lonely Island is inhabited by Guillemots the subspecies remains still unknown. The single female specimen procured by the "Vega" Expedition on Preobraschenie Island has a wing-length of 218 mm. (8.5 inches) and a culmen of 41 mm. (1.63 inches) and as a female obviously approaches in dimensions the eastern form (average wing 8.71 inches, culmen 1.65) and exceeds those of the typical form (average wing 8.24 inches, culmen 1.45). Likewise the female obtained by Dr. V. Katin-Jartzeff of the Russian Polar Expedition in the strait between Kotelny and Bielkovski Islands, a bird obviously belonging to the breeding ground situated on the western

coasts of Kotelny Island, must also be referred to *Uria lomvia arra* (Pallas) since its wing measures 220 mm. (8.62 inches) and its bill 45 mm. (1.77 inches). Finally the twenty specimens collected by the Russian Hydrographic Expedition to the Arctic Ocean, in part from General Wilkitzky Island and in part from the mouth of the Lena, have been identified as of this race by the late V. Bianchi who had the kindness to transmit to me these notes and an unpublished paper. To the same subspecies must evidently be referred the Guillemots seen by the "Vega" Expedition in the vicinity of Bear Island, near the mouth of the Kolyma (Sect. XIX) (Palmén, *l.c.*, p. 387, 1887) as well as the colony of Koljuchin Island (Sect. XXI). The Russian Polar Expedition had occasion to note a specimen of a Guillemot, 3 September 1901, in the open sea off the eastern part of Taimyr (Sect. XIII) (Birula, 1907) as well as sundry lone individuals between 5–11 September 1901, during the passage of the "Sarja" between the Taimyr peninsula (Sect. XIII) and the New Siberian archipelago (Sect. XVI) and a considerable number near Cape Emma of Bennett Island (Sect. XVII). Further, the same Expedition noted the breeding places of this bird at several localities cited above in the New Siberian archipelago. We are quite without data on the periodic events of their life that might be compared with those of the typical form.

Cepphus grylle (Linné).—Of all the coastal regions of the Eurasian Arctic Ocean, it is only the Murman coast (Sect. III) that is regularly inhabited by the Black Guillemot during its nesting season. In the latitudes of the Kanin peninsula (Sect. IV) it has been identified by N. Smirnow (Ornith. Monatsb., vol. 12, p. 206, 1901).

15. **Cepphus mandti** (Lichtenstein).

Uria. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 158–160, 1904.

Cepphus mandti (Lichtenstein). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 8, 9, 41, 1907. Toll, Die Russ. Polarf. d. "Sarja," p. 478–479, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: adult, 18 May 1902, and adult female, 4 June 1902, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff); adult, 15 June 1903, Nerpalach, Kotelny Island, New Siberian archipelago (P. Olenin); female, 7 February 1902, between Ljakoff Island and the mainland (Baron Toll and M. Brusneff).

In alcohol: head, 30 June 1902, New Siberia Island (A. Birula).

Eggs: (two), 21 July 1902, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff).

Local names: in Yakut, *tas-kuga* (duck of the rocks) (Brusneff, *in litt.*); in Chuckche, *tsóadlin* (Palmén, *l. c.*, 1887).

Without doubt, Mandt's Guillemot inhabits all the parts of the Eurasian Arctic Ocean from Spitzbergen to Bering Strait. It nests, however, on only the rocky portions of these coasts, merely wintering in the regions of low sandy or muddy coasts if there are spaces of sea to be found free of ice. One might even suppose that it winters also occasionally along the Siberian coast between the mouth of the Lena and Bering Strait although Baron Toll (1909) alone killed a specimen (7 February 1902) between Ljakoff

Island and the mainland. The natives of the northern coast of the Chuckche peninsula told the members of the "Vega" Expedition that this Guillemot sometimes spends the winter along the coasts of this peninsula.

In Spitzbergen (Sect. I) Mandt's Guillemot nests in considerable numbers though less commonly than *Uria lomvia lomvia* (Linné) while scattered pairs breed on Bear Island (Sect. II). It likewise breeds, according to Gorbunow (The *Bazary* of Nova Zembla, p. 21, 1925; *et in litt.*) on the gull rocks around the two islands and the most northern *bazar* is situated on Cape Jelanija (Sect. VIII). In the Franz Josef archipelago (Sect. IX), probably also on Ujedinenia (Lonely Island) (Sect. XI) (Mohn, Die Insel Einsamkeit im Sibir. Eism., Peterm. Geogr. Mitth., 1879, p. 57–59), in Eastern Taimyr (Sect. XIII), probably on Preobraschenie Island (or Isle of the Transfiguration of Our Lord), on Stolbowoi Island (Toll, 1909) and the western parts of the Bielkovski and Kotelny Islands (Matiessen, *in litt.*) of the New Siberian archipelago (Sect. XVI). During the breeding season it abounds on some of the islands of the De Long group: Bennett, Henriette and General Wilkitzky (specimens in our Zoölogical Museum brought back by the Russian Hydrographic Expedition to the Arctic Ocean) (Sect. XVIII), and on Wrangel and Herald Islands (Sect. XX). Finally, according to Professor Palmén (1887), one of the natives of the north coast of the Chuckche peninsula (Sect. XXI) informed the members of the "Vega" Expedition that Mandt's Guillemot nests on the rocky portions of the coast in the vicinity of Jinretlen, while according to Koren (Thayer and Bangs, 1914) it breeds at Cape Kyber and Cape Irkajpij as well. Amory took a male 9 August 1915 at Cape Bolshoi Baranow (Sect. XIX) (Riley, 1918, p. 611). Elsewhere on the coast of the Arctic Ocean it is only a wintering bird and has been reported from the Murman coast (Sect. III), the latitudes of Vaigach Island (Sect. V), the Kara Sea (vicinity of Cape Tolsty—specimen in our Zoölogical Museum brought back by Wardropper of the Scientific Expedition of the Kusnetzow brothers, under H. Backlund),—of Western Taimyr (Sect. XII) and probably on parts of Eastern Taimyr (Sect. XIII). For the region between the mouth of the Lena on the west and the north coast of the Chuckche peninsula on the east, we have no records whatever but may assume that Mandt's Guillemot sometimes winters here, in view of the specimen above noted, taken by the late Baron Toll and the reports of its wintering, communicated by the Chuckches to the members of the "Vega" Expedition.

The Russian Polar Expedition failed to meet with this species during the first year of its voyage, either in the Kara Sea or in the latitudes of Western Taimyr. It was not until the crossing of the "Sarja" toward the New Siberian archipelago, between 6 and 11 September 1901, that it was observed, according to Birula (1907). In addition to the specimen taken by the late Baron Toll (1909) between the mainland and Little Ljakoff

Island, Naval Lieutenant Kolchak noted this Guillemot, 4 June 1903, in the same place. In the New Siberian archipelago this bird was found breeding on Bielkovski Island by Th. Matiessen (*in litt.*), on Stolbowoi Island, 25 June 1902, by Naval Lieutenant Kolchak (Toll, *l.c.*, 1909, p. 574) and on Strysheff Island (Dr. Katin-Jartzeff, *in litt.*). On Kotelny Island breeding places were found on the southwest coasts (Kolchak, *in litt.*), at the mouth of the Choukotskaja River (Dr. V. Katin-Jartzeff, *in litt.*; Toll, 1909) and near the Ogrin promontory (Dr. V. Katin-Jartzeff, *in litt.*). At Bennett Island the Mandt's Guillemot was first noted 12 September 1901, while the "Sarja" was approaching the island (Birula, 1907) and again as an abundant nesting bird there during Baron Toll's visit in 1902 (Toll, 1904, 1909).

Mandt's Guillemot winters in limited numbers in the latitudes of Spitzbergen (Pike in Chapman, Wild Norway, p. 347–348, 1897) and arrives on its breeding grounds in the high latitudes at the beginning of spring. In Spitzbergen its regular appearance seems to take place at the end of February or in the first days of March; 3 March 1873, according to Nordenskiöld (Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 2, no. 18, p. 59, 1875); 14 March 1900, according to Birula (Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 170, 1910) and Bianchi (*ibid.*, vol. 7, p. 313, 1902), though sometimes its arrival is not for nearly a month later, between 3 and 8 April 1912, as observed by Dr. Rempp (Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 106, 1913). In the Franz Josef archipelago it also arrives very early in the season—in 1882 on 18 February (*fide* Dr. Neale, Clarke, Ibis, 1898, p. 270; Markham, Proc. Roy. Geogr. Soc. London, vol. 5, p. 210, 1883); in 1895 on 25 February (Jackson, A Thousand Days in the Arctic, p. 395, 1899; and observation of Dr. Koettlitz, see Clarke, 1898), while Nansen (Collett and Nansen, Norw. North Pol. Exp., p. 37, 1899) saw the first birds still later, to the northeast of the Franz Josef archipelago, namely on 10 March 1896; and finally in 1897 small numbers arrived there 4 March and the bulk on 17 March. For Nova Zembla (Sect. VIII) we have at hand only the notes of Kriwoscheja (Nature and Hunting, no. 11, p. 39, 1884 (in Russian)), according to whom Mandt's Guillemots appeared there before 6 April 1883, and of Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 96) who saw a single bird at Matochkin-shar, 22 February and the bulk 24 May 1903.

The data as to the different periods in the propagation of Mandt's Guillemot may be only approximately stated, since the young birds leave their nesting burrows rather late in the season which makes it difficult to tell exactly the time when they were hatched. Professor König (Avif. Spitz., p. 255, 1911), by reckoning the incubation period at twenty-four days, calculated that the eggs were laid 10 June 1907, in case of a set at Spitzbergen (Sect. I), which, on 5 July, contained one young bird a few days old. In the same year he found a perfectly fresh set in Prince Charles Land on 24 June and on 5

July 1908, on King Louis Islands many fresh eggs. Walter (Journ. f. Ornith., vol. 38, p. 240, 1890) noted the first young on 6 August 1890, but he fails to tell us whether the chick had just hatched or whether his observation referred to a young bird already taken to the water. Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 138, 1900) saw on 19 August young birds that had not yet left the nest and others that were swimming in the sea; Birula (Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 170, 1910) tells us that he noted the first young bird at Storfjord, 22 August; finally according to Münsterhjelm (Öfv. Finska Vet. Soc. Förh., vol. 53, p. 20, 1910) young birds were beginning to fly after 15 August 1910. On Bear Island (Sect. II) Swenander (Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 26, no. 3, p. 33, 1900) noticed young birds in two nests on 4 July 1899. For Vaigach Island (Sect. VII) Heuglin (Reise n. d. Nordpolarmeer, vol. 3, p. 161, 1874) gives 5 September as the time when the first young begin to fly, evidently a late date, while according to Bilkiewicz (App. Sci. Res. Exp. Univ. of Kasan, 1904, p. 14) they left their nests in Nova Zembla (Sect. VIII) about the last days of July. These results do not accord with the observations of Schaanning (1907) who, at Matochkin-shar, found the first eggs in two nests, 10 July and 15 July 1903, respectively.

When Mandt's Guillemot leaves its breeding grounds in the autumn it merely seeks the open sea near by as has been convincingly shown by Münsterhjelm (Öfv. Finska Vet. Soc. Förh., vol. 53, p. 20, 1910). This explorer observed the departure of all the adult birds and probably also most of the young from Spitzbergen on 30 August 1910, for he was able to find only a few solitary young birds, and, on 15 September, the young birds also left Bell Sound, but on 30 September 1910, he succeeded in rediscovering adults and young in the open sea at a distance of some leagues from land. In 1899 according to Bunge these birds frequented Horn Sound as late as 3 November (Birula, 1910). At Matochkin-shar, Nova Zembla, Schaanning (1907) noted the last individuals, 18 November 1902. He supposed, however, that these birds were wintering in the Nova Zembla region because during the winter of 1902–03, sundry birds had been found in the neighboring tundra. For the Franz Josef archipelago we have at hand the following data as to the departure of this species: in 1881, it disappeared during the first week of September (*fide* Dr. Neale, Clarke, Ibis, 1898, p. 270); in 1894, Jackson (A Thousand Days in the Arctic, p. 395, 1899) saw the last two individuals on 23 October; in 1895, the Mandt's Guillemots left Cape Flora according to Dr. Koettlitz (Clarke, 1898), on 1 October and 10 October according to Jackson (1899), and in 1896, 22 October (Clarke, 1898; Jackson 1899).

From Dr. Bunge's observations (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 312, 1902) at Spitzbergen the change from winter to summer plumage takes place in the very brief period of a few days; according to Bilkiewicz (1904) the autumnal

moult begins in the end of August and by September in the latitudes of Nova Zembla the birds are in winter dress; Gorbunow (*in litt.*) observed, on 23 August 1923, a Guillemot in winter dress in the Puchowaja Bay (South Island). The crew of the "Fram" (Collett and Nansen, *l.c.*, p. 51, 1899) observed Mandt's Guillemot in considerable numbers in the regions beyond the 84th parallel and saw it as far north as 84° 32′ north latitude.

Pseuduria (=**Cepphus**) **columba** (Pallas).—This Guillemot has been recorded by Nelson (Cruise of the Corwin, p. 117, 1883) as breeding abundantly on Wrangel and Herald Islands (Sect. XX) and in sundry places on the north coast of the Chukche peninsula (Sect. XXI) such as the neighborhood of East Cape (Mys Wostochny) and Cape Serdze-Kamen, as well as by Koren between Bering Strait and the Koljuchin Bay (Thayer and Bangs, 1914). The identification of a Guillemot seen by one of the crew of the "Vega," on 11 July 1879, at the winter-quarters of the vessel, should be regarded as uncertain (Palmén, Sibir. Ishavsk. Fogelf., p. 391, 1887). The Russian Polar Expedition did not meet with this species.

Alca torda Linné.—Single individuals of the Razor-bill have been recorded from Spitzbergen (Sect. I) and Bear Island (Sect. II) (König, Avif. Spitzb., p. 260, 1911; Jourdain, Ibis, 1922, p. 176) and it breeds in considerable numbers on the *bazary* (gull rocks) of the Murman coast (Sect. III). A single specimen of the Razor-bill was, according to Gorbunow (The *Bazary* of Nova Zembla, p. 19, 1925) killed in spring 1924, on the Bazarny Island in the Little Karmakuly Harbor. The Russian Polar Expedition was unable to find this bird in the parts of the Eurasian Arctic Ocean visited.

Simorhynchus (=**Aethia**) **cristatellus** (Pallas).—This species of Auklet was seen by Nelson (Cruise of the Corwin, p. 116, 1883) in far smaller numbers than the Guillemots at Herald Island; while at Wrangel Island (Sect. XX) solitary individuals were noted and a small flock was seen at Cape Iksurin (Sect. XXI) by Koren (Thayer and Bangs, 1914). The Russian Polar Expedition did not meet with it.

Ciceronia (=**Aethia**) **pusilla** (Pallas).—Data as to this representative of the Alcidae are limited to the notes of Professor Palmén (Sibir. Ishk. Fogelf., p. 398, 1887) on the one hand and of Koren (Thayer and Bangs, 1914) on the other. According to the former, a specimen of this species was taken by Naval Lieutenant Brusewitz in the autumn of 1878 at the winter-quarters of the "Vega" on the north coast of the Chukche peninsula (Sect. XXI), while the latter observed a single bird at Cape Iksurin.

Mergulus (=**Alle**) **alle** (Linné).—The Little Auk breeds by the million in the northern parts of the islands and archipelagoes of the Eurasian Arctic Ocean, eastward as far as the Kara Sea. According to Professor König (Avif. Spitzb., p. 256 ff., 1911) it is very abundant in Spitzbergen (Sect. I) in the breeding season and frequents Bear Island (Sect. II) in moderate numbers.

In Nova Zembla (Sect. VIII) it breeds only on the northern island and only winters in the latitudes of the southern island (Bilkiewicz, App. Sci. Res. Exped. of Univ. of Kasan, 1904, p. 16, 1907); according to Gorbunow (*in litt.*) the most southern breeding place of this Auk is situated in the Archangelski Bay; a colony breeds on Cape Jelanija, the most northern point of the northern island. Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 96) has succeeded during his sojourn at Matochkin-shar in 1902 and 1903, in obtaining only a single young bird 4 October 1902. It occurs in countless numbers in suitable breeding places on a number of the islands of the Franz Josef archipelago (Sect. IX) such as Torup Island (81° 33′ north latitude), Prince Rudolph Land (81° 44′ north latitude), Cape Felder, Cape Holland, Frederick Jackson Island, Cape Hugh Mill, Cape McClintock, Cape Richthofen, Cape Grant, Cape Flora. At the close of the nesting season the Little Auk leaves its breeding grounds and repairs to the adjacent regions of the Arctic Ocean that are free of ice, and winters to a certain extent in the latitudes of the

southern island of Nova Zembla (Sect. VIII) and along the Murman coast (Sect. III) where a few scattered pairs may remain to nest.

As to the time of its appearance in the latitudes of Spitzbergen (Sect. I) we may adduce the following notes: in 1873 the first individuals were seen in Mossel Bay 4 April (Nordenskjöld, Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 2, no. 18, p. 59, 1875); in 1899 the first flock appeared at Horn Sound according to Dr. Bunge, on 8 April, flying at a great height, and on 16 April a small number of little flocks (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 308, 1902); in 1900 at Horn Sound, the first were seen on 17 March by the same observer (Birula, *ibid.*, vol. 15, p. 182, 1910); and finally, according to the whaler Sendsen, the first birds were seen at Prince Charles Foreland, 27 February (Münsterhjelm, Oefv. Finska Vet. Soc. Förh., vol. 53, p. 20, 1910). In the Franz Josef archipelago (Sect. IX) the Little Auk arrived at Cape Flora, 2 March 1882 (observation of Dr. Neale, Clarke, Ibis 1898, p. 272; and Jackson, A Thousand Days in the Arctic, p. 408, 1899); 25 February 1895 and 27 February 1896 (Jackson, 1899; and observation of Dr. Koettlitz, Clarke, 1898); and finally in 1897, on 6 March (Jackson, 1899) and 9 March after Dr. Bruce (Clarke, 1898). At Nansen's winter-quarters in 1896, some ten Little Auks appeared two days before his arrival at Cape Flora, that is, on 25 February, while the greater part of the birds, numbering millions of individuals, arrived there 10 March (Collett and Nansen, Norw. North Pol. Exp., pp. 41, 42, 1899).

The breeding of the Little Auk takes place at Spitzbergen (Sect. I) at the following times: Professor König (1911) places the normal time of egg-laying at the end of June or early July, while, according to Kolthoff (Öfv. Kongl. Svenska Vet. Akad. Förh., vol. 36, no. 9, p. 86, 1903) the first fresh eggs were found 19 June 1900, and according to Birula (1910, p. 178), on 30 June 1899. At Bear Island (Sect. II) these birds appear to nest somewhat earlier, for Jourdain (Ibis, 1922, p. 177) tells us that the Oxford Expedition found fresh eggs there 16 June 1921. Count Zedlitz (Journ. f. Ornith., vol. 59, p. 307, 1911) found that none of the young birds had taken to the sea by 10 August 1910. Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 139, 1900) record their belief that even by mid-September the young have not yet begun to fly in Spitzbergen.

As to the time when the Little Auks leave the high latitudes, we have the following data at hand: at Spitzbergen, Pike (Chapman, Wild Norway, p. 344, 1897) saw the last ones at Amsterdam Island 13 October; Birula (1910, p. 177), states that these birds were leaving Horn Sound about the middle of August in 1899 and were quite gone by 30 August. In the Franz Josef archipelago Dr. Neale says (Clarke, 1898) that the Little Auks disappeared in the first week of September, 1881, at Cape Flora; according to Jackson, (1899) the last were seen 28 August 1895 and 1896, while Dr. Koettlitz saw them in 1895 up to 1 October, and Bruce in 1896 up to 14 September (Clarke, 1898).

The first Little Auks were seen by Bilkiewicz (1907) in the southern parts of Nova Zembla on 2 October 1904, while ordinarily they first appear there in mid-October. Nansen (Collett and Nansen, Norw. North Pol. Exp., p. 39, 1899) met with them as far north as 82° 20′.

Brachyrhamphus brevirostris (Vigors).—A male example of this species was killed by Lieutenant Brusewitz, 22 June 1879, at the winter-quarters of the "Vega" on the north coast of the Chuckche peninsula (Sect. XXI) (Palmén, 1887). In the same regions it was noted by Koren (Thayer and Bangs, 1914) between Bering Strait and Cape Yakan.

Ombria (=**Phaleris**) **psittacula** (Pallas).—The Parroquet Auklet was found, 29 June 1881, by Nelson (Cruise of the Corwin, p. 115, 1883) in the latitudes of Cape Serdze-Kamen on the north coast of the Chuckche peninsula (Sect. XXI).

LARIFORMES.

Stercorariidae.

Megalestris catarrhactes (Linné) (=**Stercorarius skua** (Brünnich)).—The Skua is only an accidental visitor in the western portions of the Eurasian Arctic Ocean. No instance of its breeding has yet been recorded though it has been seen in pairs at Spitzbergen. Professor König (Avif. Spitzb., p. 195, 1911)

gives the following records for Spitzbergen (Sect. I): 25 July 1898, a specimen was taken in Research Bay, and is now in the Museum of the University of Göttingen; König himself also saw one, 23 June 1907, in Van Keulen Bay and a second, 26 June in Kings Bay; finally Römer and Schaudinn observed two pairs of these birds at Spitzbergen in 1898. Mathey-Dupraz (Bull. Soc. Sci. Nat. Neuchâtel, vol. 38, p. 41, 1911) believes he saw this species at Bear Island (Sect. II), though he deems it necessary to put a question-mark with his identification. For the Murman coast (Sect. III) we have, in addition to sundry older records from the region of Varanger Fjord, the statements of Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903 (in Russian)) according to which this species has been found in the western parts of the Murman coast, as particularly in the district of Pasvig-elf, as well as on the open ocean. In 1901, Smirnow (Ornith. Jahrb., vol. 12, p. 208, 1901) noted the Skua 8 July and again on 10 July between Kolguev Island (Sect. V) and the mainland; while Baer and Smirnow (1901, p. 209) have reported it from the southern island of Nova Zembla (Sect. VIII). The Russian Polar Expedition nowhere met with this species.

16. Stercorarius pomarinus (Temminck).

Stercorarius pomatorhinus (Temminck). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 238, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 4, 6–9, 11–13, 15, 17–19, 60, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult female, 14 July 1901, west coast of Taimyr Strait (Dr. H. Walter); male and female, 4 July 1902, Nerpalach Bay, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff); female, 23 October 1902, Island of New Siberia (A. Birula); young, September 1901, Kotelny Island (A. Birula); female, 14 June 1902, Elijdep promontory, mouth of the Lena (M. Brusneff).

Skeletons: Nerpalach Bay, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff); ? probably from island of New Siberia (A. Birula).

Eggs: two, 3 July 1902, and one (of two), 4 July 1902, Nerpalach Bay, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff); two, 24 June 1903, two, 1 July 1903, two, 5 July 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow).

Local names: in Samoyede, on Kolguev Island, *huriu* (Trevor-Battye); in Taimyr, *föptuă* (Middendorff); in Russian in the Yana and Indigirka regions, the Jaegers in general are called *terbei;* in Yakut, *tyrjácha* or *kara-tyrjacha* and in Tunguse, *prakel* (to indicate the different species the natives of these countries add to the names just given, adjectives meaning "large" or "small" (Birula)); in Chuckche, *aunuklin uadl'-ukanodlin* (Palmén).

As a circumpolar bird, the Pomarine Jaeger is recorded for all the sections of the Eurasian tundra except the De Long group of islands (Sect. XVII). In the western portions —Spitzbergen (Sect. I), Bear Island (Sect. II), Murman coast (Sect. III)—it either does not nest at all or does so but rarely. Birula (1907) tells us that while the two other species fly about back and forth over the tundra in their search for food—lemmings, eggs and young birds—the Pomarine Jaeger chiefly haunts the shores of the Arctic Ocean, at least when free of ice, and chiefly lives on the plunder that it succeeds in taking from the Gulls. The Russian Polar Expedition found this species in all the countries visited, as in the Kara Sea (Sect. X) (Birula, 1907), abundantly in the neighborhood of the "Sarja's" first winter-quarters in Western Taimyr (Sect. XII) (Walter, 1902, *et in litt.;* Birula, 1907).

at Kotelny Island near Nerpalach (Dr. Katin-Jartzeff, *in litt.*) and near Camp Jelissejeff (Kolchak, *in litt.*), at the Island of New Siberia (Birula, 1907) and in 1903 at Faddejefski Island (Tolstow, *in litt.*); finally, the auxiliary expedition under Brusneff secured a female from the Siberian mainland on the Elijdep promontory in the region of the Lena's mouth (specimen in the collection).

The arrival of the Pomarine Jaeger in the latitudes of the Eurasian tundra has been noted on the following dates: according to Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) it appeared at Yeretiki 27 May 1899, and at Alexandrovsk (west part of the Murman coast) (Sect. III) on 31 May 1901. In the neighborhood of Matochkin-shar, Nova Zembla (Sect. VIII) Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 91) records its arrival on 19 June 1903. In Western Taimyr (Sect. XII) its first appearance was noted by Dr. Walter (*in litt.*) 13 June 1901, and by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 240, 1853) 18 June 1843, under 74° of north latitude. It appeared at the Island of New Siberia on 30 June 1902 (Birula, 1907) and at Kotelny Island by the beginning of June 1903, near the Medweshi promontory; and finally in some numbers 18 June in the vicinity of Camp Michailow.

Concerning the breeding of the Pomarine Jaeger we have the following data at hand. In the Yamal peninsula, at the mouth of the Morda River (Sect. X) Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 339, 1912) found a single fresh egg (probably from an uncompleted set) on 13 June. In 1902 Schaanning (1907) did not see this species in Nova Zembla (Sect. VIII) but in 1903 it was very numerous there and he discovered nine sets in which the first egg was laid on the dates following: 26 June, 28 June, 28 June, 30 June, 30 June, 1 July, 2 July, 12 July, 14 July. In Western Taimyr (Sect. XII) the Russian Polar Expedition was unable to secure evidence of the breeding of this bird through the discovery of eggs, but Middendorff (1853) found the first eggs 19 July 1843. In the New Siberian archipelago (Sect. XVI) nests of this Jaeger have been certainly identified on two of the islands (Kotelny and Faddejefski); the egg that Birula (1907) collected 3 July 1902 on the Island of New Siberia has not reached us so that I have been unable to identify it with certainty. Dr. Katin-Jartzeff (*ex. coll. et in litt.*) collected sets of eggs of this species 3 and 4 July 1902, in the vicinity of Nerpalach Bay and Tolstow (*ex. coll. et in litt.*) took eggs on Faddejefski Island 24 June, 1 July and 5 July 1903.

The five sets of eggs of the Pomarine Jaeger brought home by the Russian Polar Expedition furnish the opportunity for the following observations:

1. Two eggs, 3 July 1902, Nerpalach Bay, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff).—These two eggs differ rather notably in their much brighter coloration, of a yellowish-brown tint and even yellowish gray on one of them (*b*). Their dimensions and weights are: 64 mm. x 44 (389 cg.); 63 x 42 (369 cg.).

2. One egg (of two), 4 July 1902, same data.—Coloration normal. Dimensions and weight: 60 mm. x 44 (389 eg.).

3. Two eggs, 24 June 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow).—Coloration normal. Dimensions and weights: 62.5 mm. x 45 (395 eg.); 61 x 44 (332 eg.).

4. Two eggs, 1 July 1903, same data.—"The nest was situated in a low, moss-covered part of the tundra; it resembled the nests of Gulls and was carefully lined with dry turf and fine dried grasses, with a depth of about 2.5 cm.; the eggs were perfectly fresh." Coloration normal. Dimensions and weights: 67 mm. x 44.5 (458 eg.); 66.5 x 45 (457 eg.).

5. Two eggs, 5 July 1903, same data.—Coloration normal. Dimensions and weights: 64.2 mm. x 47.1 (477 eg.); 66 x 47.2 (460 eg.).

It appears that the Pomarine Jaeger left the latitudes of Western Taimyr (Sect. XII) in 1901 at a very early date for, according to Dr. Walter's observations (*in litt.*), it was not met with after 6 August. In 1902 Birula (1907) recorded the last birds at the Island of New Siberia on 23 September and in 1903 Kolchak (*in litt.*) last noted them 30 September near Camp Michailow, on Kotelny Island. The "Fram" Expedition (Collett and Nansen, Norw. North Pol. Exp., p. 50, 1899) found this species as far north as 82° 57′.

17. **Stercorarius crepidatus** (Banks) (=**parasiticus** (Linné)).

?*Stercorarius crepidatus* (Banks). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 2, p. 238; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902.

Stercorarius crepidatus (Banks). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 5, 15, 17 18, 60, 61, 1907.

List of Specimens from the Russian Polar Expedition.

Skin: adult female, 6 August 1902, Island of New Siberia (A. Birula).

Local names: The names of all the species of Jaegers are the same in the native languages of northern Siberia according to Birula and have been already cited in the article on the Pomarine Jaeger. They only differ by the adjectives "large" or "small." In the Chukchi tongue it is called *uudl' ukangodlin* (Palmén).

The Parasitic Jaeger, representing a circumpolar species, has been reported in all the sections of the Eurasian tundra except the De Long group of islands (Sect. XVII) as well as Wrangel and Herald Islands (Sect. XX). Nevertheless this bird is much more plentiful in the western parts of the region, as in Spitzbergen (Sect. I), Bear Island (Sect. II) and on the Murman coast (Sect. III); from the Kara Sea eastward it becomes more and more scarce and the Long-tailed Jaeger evidently predominates all along the coasts of Siberia. The Russian Polar Expedition brought back only a single female of this species, taken 6 August 1902, by Birula on the Island of New Siberia. It was observed in 1901 in the vicinity of the first wintering place of the "Sarja" in Western

Incubation period 28 days Young leave nest and begin to fly after 27 days		Spitzbergen	Bear Island	Kola Peninsula (Murman coast)	Kolguev Island	Franz Josef Archipelago
No. of Section		I	II	III	V	IX
Time of egg-laying	Early dates	12 Je 1908[1] *26 Je 1908*[1] (eggs incubated or heavily incubated—14 days)	*13 Je 1861*[7] *20 Je 1921*[12] 10 Je 1921[12] (eggs incubated nearly 10 days)	*9 Je*[9] 13 Je[9] *3 Jy*[9] (eggs heavily incubated—20 days)	13 Je 1894[10] 15 Je 1894[10] *29 Je 1894*[10] (eggs half incubated—14 days)[10]	
	Normal dates	23 Je 1910[2] *7 Jy 1910*[2] (eggs heavily incubated—14 days) 23 Je 1899[3] Ginevra Bay 25 Je 1923[12] Wijde Bay 26 Je 1910[2] 29 Je 1899[3] Horn Sound 30 Je 1923[12] Cape Ross 30 Je 1923[12] Liefde Bay *30 Je 1900*[4] (one egg slightly incubated—2 days) 3 Jy 1900[4] 3 Jy 1900[4] (eggs incubated—10–12 days) *14 Jy 1900*[4]	20 Je 1899[8] *12 Jy 1899*[8] (eggs heavily incubated—20 days) 22 Je 1899[8] 29 Je 1899[8]	30 Je[9] *3 Jy*[9] (eggs slightly incubated—3 days		*27 Je 1897*[11]
	Late dates	*5 Jy 1908*[1] (eggs fresh) 4 Jy 1881[5] 4 Jy 1900[4] *6 Jy 1900*[4] 7 Jy 1910[6] 15 Jy 1923[12] Cape Sparre	*3 Jy 1899*[8] 11 Jy 1907[1] (eggs slightly incubated—3 days) *14 Jy 1907*[1]			

[1] König, Avif. Spitzb., p. 199, 1911.
[2] Münsterhjelm, Oefv. Finska Vet. Soc. Förh., vol. 53, p. 20, 1910.
[3] Birula, Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 169, 1910 (in Russian).
[4] Observation of Dr. Bunge, Bianchi, *ibid.*, vol. 7, p. 307, 1902 (in Russian).
[5] Cocks, Zoologist, 1882, p. 411.
[6] Zedlitz, Journ. f. Ornith., vol. 59, p. 308, 1911.
[7] Malmgren, Journ. f. Ornith., vol. 13, p. 205, 1865.
[8] Swenander, Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 26, pt. 4, no. 3, p. 25, 1900.
[9] Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130, 1903 (in Russian).
[10] Trevor-Battye, Ice-bound on Kolguev, p. 438, 1895.
[11] Observation of Dr. Bruce, Clarke, Ibis, ser. 7, vol. 4, p. 269, 1898.
[12] Langstaff, Ibis, ser. 11, vol. 6, p. 492, 1924.

		Spitzbergen	Bear Island	Kola Peninsula (Murman coast)	Kolguev Island	Franz Josef Archipelago
No. of Section		I	II	III	V	IX
Time of hatching	Early dates	10 Jy 1908[1]	16 Jy 1861[7] 13 Jy 1921[12]	7 Jy[9] 11 Jy[9]	11 Jy 1894[10] 13 Jy 1894[10]	
	Normal dates	21 Jy 1910[2] 21 Jy 1899[3] Ginara Bay 23 Jy 1923[12] Wijde Bay 24 Jy 1910[2] *27 Jy 1899*[3] (first young in down) Horn Sound *23 Jy 1923*[12] Cape Ross 28 Jy 1923[12] Liefde Bay 30 Jy 1900[4] 30 Jy 1900[4]	*20 Jy 1899*[8] 20 Jy 1899[8] 27 Jy 1899[8] *29 Jy 1899* (young two days old)[8]	28 Jy[9]		25 Jy 1897[11]
	Late dates	2 Ag 1908[1] *1 Ag 1881*[5] 1 Ag 1900[4] *4 Ag 1910*[6] *12 Ag 1923*[12] Cape Sparre	1 Ag 1899[8] 8 Ag 1907[1]			
Time when young birds begin to fly.	Early dates	6 Ag 1908[1]	12 Ag 1861[7] 4 Ag 1921[12]	3 Ag[9] 7 Ag[9]	*7 Ag 1894*[10] (remiges full grown) 9 Ag 1894[10]	
	Normal dates	17 Ag 1910[2] *17 Ag 1899*[3] Ginara Bay *19 Ag 1923*[12] Wijde Bay *20 Ag 1910*[2] 23 Ag 1899[3] Horn Sound 24 Ag 1923[12] Cape Ross *24 Ag 1923*[12] Liefde Bay 26 Ag 1900[4] 26 Ag 1900[4]	16 Ag 1899[8] 16 Ag 1899[8] 23 Ag 1899[8]	24 Ag[9]		21 Ag 1897[11]
	Late dates	29 Ag 1908[1] 28 Ag 1881[5] 29 Ag 1900[4] 31 Ag 1910[6] 8 Sept 1923[12] Cape Sparre	28 Ag 1899[8] 4 Sept 1907[1]			

Taimyr by Walter (1902, *et in litt.*) and Birula (1907); while Kolchak (*in litt.*) likewise made mention of the fact that he saw this species on Faddejefski Island. As to the time when the Parasitic Jaeger arrives in polar lands, we have at hand the following data. In Spitzbergen (Sect. I) this bird appeared according to Professor König (Avif. Spitzb., p. 198, 1911) at the end of the month of May, which corresponds to the following more exact dates, namely, 30 May 1889, on Stor Fjord observed by Pike (Chapman, Wild Norway, p. 350, 1897); 2 June 1900, seen by Dr. Bunge (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 307, 1902). On the Murman coast (Sect. III) Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) noted its arrival in Yeretiki Bay, 20 May 1882, 19 May 1883, 21 May 1884, 15 May 1896, 24 April 1899, 16 April 1900; and at Alexandrovsk, 10 May 1901. In the Franz Josef archipelago (Sect. IX) it appeared at Cape Flora, according to Jackson (A Thousand Days in the Arctic, p. 400, 1899), 11 June 1895 and 13 June 1896; according to the observations of Dr. Koettlitz (Clarke, Ibis, 1898, p. 269), 17 June 1895 and 12 June 1896; in 1897 Wilton (Clarke, 1898) saw the first birds on 15 April. Smirnow (Compt. Rend. Acad. Sci. U. S. S. R., 1926, p. 33) observed in both years 1924 and 1925 between 10 and 20 May flocks and single specimens flying in a northerly direction through the mouth of the White Sea (between Sect. III and IV). In Western Taimyr (Sect. XII) it appeared, according to Birula (1907), about 25 May 1901, and was certainly identified on 30 May.

Data as to the different periods of propagation of this bird are rather numerous. The incubation period according to König (1911) lasts about four weeks and Swenander (Bih. Kongl. Svenska Vet. Akad. Handl., vol. 26, pt. 4, no. 3, p. 25, 1900) has succeeded in showing that a young one hatched 20 July was first on the wing by 16 August, that is to say, that between the hatching and the time when the bird is able to fly 27 days elapse.

These facts permit us to make the following deductions. In Spitzbergen, (Sect. I) the usual egg-laying period is between 28 June and 3 July which accords completely with the generalizations made by Birula[3] and König[1]; nevertheless fresh eggs may be found as early as June 12, and sometimes the sets are later and the eggs are still fresh at the end of July (observation of Zedlitz[6]). On Bear Island (Sect. II) egg-laying takes place at about the same time, while on the Murman coast (Sect. III) and Kolguev Island (Sect. V) it is a little later. The hatching of the young birds sometimes takes place in mid-July, usually between 21 and 31 July, and in late years after 2 August; young birds sometimes begin to fly in mid-August, normally in the second part of August and in late years about 1 September.

18. Stercorarius longicaudus Vieillot.

Stercorarius longicaudatus. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 388, 1901.
Stercorarius parasiticus (Linné). Walter, *ibid.*, vol. 16, no. 5, p. 238, 1902; Annuaire Mus. Zool. St.

Pétersbourg, vol. 7, p. 160, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 4–7, 11–16, 60, 61, 1907.

Stercorarius. Brusneff, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 181, 1904.

Lestris longicauda (Vieillot). Toll, Die russ. Polarf. d. "Sarja," p. 322, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: adult male and female, 20 August 1900, Western Taimyr (Dr. H. Walter); adult male and adult female, 8 July 1901, west coast of Taimyr Strait (Dr. H. Walter); adult, 19 June 1902, taken during Kolchak's excursion to Faddejefski Island (Dr. V. Katin-Jartzeff); adult, 8 June 1901, Wanjkin promontory, Great Ljakoff Island (O. Cionglinski); adult, 23 August 1901, Camp Michailow, Kotelny Island (O. Cionglinski); adult, 16 June 1902, mouth of the Elijdep River, Charaulach Mountains, mouth of the Lena River (M. Brusneff); two adults and young, 2 July 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff).

Skeletons: Island of New Siberia (A. Birula).

In alcohol: head of a female, 27 June 1902, Island of New Siberia (A. Birula).

Eggs: two sets of two eggs each, 8 July 1901, western shore of Taimyr Strait (Dr. H. Walter); two, 2 July 1902, Island of New Siberia (A. Birula); one, 27 June 1902, one without date, Island of New Siberia (A. Birula); one, 19 June 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff); two, 2 July 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff); one, 6 July 1903, Bolschaja River, Island of New Siberia (M. Brusneff); two, 24 June 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow).

Local names: the same as for the other species of Jaegers among the natives of northern Siberia; in the Chukche tongue, *ankakcnuadl'-ukangodlin* (Palmén).

The Long-tailed Jaeger has been recorded from all the sections of the Eurasian tundra with the exception of the De Long archipelago (Sect. XVII) and Herald Island (Sect. XX, b). From the point of view of its geographical distribution it differs from the Parasitic Jaeger in that the latter predominates in the western regions while the eastern regions are inhabited chiefly by the Long-tailed Jaeger. Although it has been found in Spitzbergen (Sect. I) and on Bear Island (Sect. II), instances of its nesting in these sections have not been recorded. In Lapland (Sect. III) it nests in the alpine zone along the Murman coast and on the mountain-summits bare of vegetation. According to Gorbunow (*in litt.*) it reaches on the west coast of Nova Zembla, the Pankratjeff peninsula (northern part of the Northern Island) and on the east coast does not go farther to the north than Russanow Bay, situated twenty miles to the north of Pachtussow Island.

In 1900 the Russian Polar Expedition met with the Long-tailed Jaeger only on 20 August to the east of Dickson Bay (Sect. XI) (Walter, *in litt.*); the coast of the Taimyr peninsula (Sect. XII) had already been deserted by this bird at the time of the arrival of the Expedition's vessel (Birula, *l. c.*). In the neighborhood of the winter-quarters of the "Sarja" in Taimyr this species was nesting in abundance in 1901 (Walter, 1901, 1902, *et in litt.;* Birula, 1907; Toll, 1909) as well as in the regions of the mouth of the Lena (Sect. XIV) whence Brusneff brought back a bird and a set of eggs taken on the Elijdep

promontory. In the New Siberian archipelago (Sect. XVI) this species is very common and has been recorded from nearly all the islands of this archipelago. Cionglinski observed it in 1901 on the Wanjkin promontory of Great Ljakoff Island (specimen in the collection); on Kotelny Island it has been found by Dr. Katin-Jartzeff (*in litt. et exempl. coll.*) in the vicinity of Nerpalach Bay as well as during a journey to the Chukotskaja River and by Kolchak (*in litt.*) on the Yelissejefskaja River in 1902 and in the vicinity of Camp Michailow and the Medweshi peninsula in 1903. On Faddejefski Island this bird was not rare either in 1902 (observation of Kolchak) or in 1903 (observation of Tolstow). On the Island of New Siberia, Birula (1907) observed it in 1902 in considerable numbers and Brusneff in 1903 had a similar experience (specimens in the collection) finding it on the Bolschaja River and in the Derewjannyja Mountains.

On the Murman coast (Sect. III) Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) recorded the arrival of the Long-tailed Jaeger at Yeretiki on 11 May 1900 and 14 May 1901, while at Alexandrovsk this bird was not observed except on 29 May of the same year. According to Smirnow (Compt. Rend. Acad. Sci. U. R. S. S., 1926, p. 33) few specimens passed the mouth of the White Sea (between Sect. III and Sect. IV) between 10 and 20 May of the years 1924 and 1925. Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 90) observed its appearance at Matochkin-shar, Nova Zembla, on 6 June 1903. In Western Taimyr (Sect. XII) it was noted by Dr. Walter (*in litt.*) 10 June and by Birula (1907) 12 June; Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 241, 1853) did not observe it in latitude 73° 45′ north until 17 June 1843. In the New Siberian archipelago Birula (1907) recorded its arrival at the Island of New Siberia, 10 June 1902 and Tolstow (*in litt.*) noted it at Faddejefski Island, 6 June 1903; finally the Long-tailed Jaeger was seen at the winter-quarters of the "Vega," north coast of the Chuckche peninsula (Sect. XXI), on 13 June 1879.

Although a certain number of records are at hand as to the different periods in the propagation of the Long-tailed Jaeger at high latitudes of the Eurasian tundra, I hesitate to draw any conclusions from them since they frequently lack indications of a sufficiently exact nature as to the state of incubation of the different sets of eggs. In those cases where I shall allow myself to draw certain deductions I will assume an incubation period of 28 days and a lapse of 27 days between the moment of hatching and the time when the young bird begins to fly, determined with a sufficient exactness in the case of the Parasitic Jaeger. On the Murman coast (Sect. III) Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130–131, 1903 (in Russian)) found sets of fresh eggs in the latitudes of the Pasvig River about the 26th of June and in the western part of the Murman coast about 2 July, which would give us in the first case 24 July and in the second 30 July as the time of hatching of the young ones, and 20 August and 26 August

as the dates when they began to fly. In the region of the northern Ural (Sect. X) Wardropper, naturalist of the expedition of the Kusnetzow brothers, under command of H. Backlund, found on the shore of Lake Nerusovoje a young individual of the Long-tailed Jaeger which, on 28 July 1909, had reached three-quarters of the size of its parents. This bird must then have hatched about 13 July and the eggs were laid about 16 June; furthermore, the same naturalist found on the shores of Lake Ossowej, on 17 August 1909, a young bird entirely feathered, which must have hatched about 21 July and the eggs of the set to which it belonged must have been laid about 23 June, which allows us to consider it as belonging to a normal brood. For Nova Zembla (Sect. VIII) there are the notes of Feilden (Markham, A Polar Reconn. "Isbjörn", p. 335, 1881) according to which a young bird was taken 4 August that was nearly half the size of the old bird and so consequently must have been hatched about ten days previously, that is, 25 July; the egg must have been laid, therefore, about 27 June and the young bird would have commenced to fly about 22 August. Schaanning (1907) did not observe this species in Nova Zembla in 1902, but in 1903 he found it nesting in quantities in the vicinity of Matochkin-shar. He found at least eighteen nests there and recorded the laying of the first egg in each nest on the dates following: 19 June, two nests; 20 June, one nest; 22 June, one nest; 23 June, seven nests; 24 June, one nest; 25 June, one nest; 30 June, one nest; 2 July, one nest; 5 July, one nest; 6 July, one nest; and 18 July, one nest. He found on 20, 24, and 27 July eggs from which the young must just have hatched and the first young were found 15 July. The data from Western Taimyr (Sect. XII) are somewhat contradictory and do not permit of obtaining an exact idea as to the dates of breeding of the Long-tailed Jaeger in these portions of the Eurasian tundra. Several sets, marked as "slightly incubated" were found by Dr. Walter (1901, 1902, *et in litt.*) between 28 June and 11 July 1901, which fixes the time of the hatching of the young birds as between 20 July and 2 August, and the time when the young birds would begin to fly about 15 to 28 August. These dates do not agree at all with the observations of Walter (*in litt.*) and Birula (1907), according to whom these birds were gathering into large flocks between 6 and 8 August 1901, and had entirely disappeared from Taimyr by 8 August, that is, at a time when, according to the above calculations, the chicks were hardly hatched. However, Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 241, 1853) observed this bird at Taimyr in the autumn as late as 4 October which gives us ground for considering his discovery of a set of eggs on 4 July as a normal occurrence. We can only explain the very peculiar observation at Taimyr in 1901 in one of two ways: either the state of incubation of these sets was much more advanced and consequently the eggs had been laid much earlier (which would correspond quite as well with the date of arrival of the Long-tailed Jaeger in Taimyr in 1901) or the eggs had been destroyed in 1901

in these regions so that the old birds could leave the high latitudes very early. The latter supposition is perhaps the more plausible since according to Birula (*l. c.*, p. 5) on 27 and 28 June 1901, there was a violent snow-storm and the temperature had fallen to -1° and -2° Cels. But these explanations do not wholly satisfy me because in 1900, when the "Sarja" arrived in Western Taimyr on 27 August no Jaegers were to be found there and Birula recorded the last Long-tailed Jaeger on the Island of New Siberia, 19 August 1920. In the New Siberian archipelago (Sect. XVI) sets of eggs were found by Birula on the Island of New Siberia 27 June (one fresh egg) and 2 July 1902, and by Brusneff (*exempl. coll.*) 2 July 1903 (Bolschaja River) and 6 July 1903 (Derewjannija Mountains); then finally 24 June 1903 by Tolstow (*in litt. et exempl. coll.*) at Faddejefski Island. On the mainland on the Eiijdep promontory, Charaulach Mountains, mouth of the Lena (Sect. XIV) Brusneff (*exempl. coll.*) found a nest which on 19 June 1902 contained but a single egg. Birula (1907) gives us the following data as to the breeding of the Long-tailed Jaeger.

At first, after their arrival, they are not yet found in pairs, from which one may conclude that the Jaegers do not mate immediately after their arrival. This bird places its nest in dry, flat places on the elevations or on their gentle slopes; there they deposit their two greenish spotted eggs directly on the soil of the tundra without even making any lining. It is this that makes it so very difficult to find the eggs of the Jaeger, even if one has marked the place from which the parent bird flew. It is only toward the end of the incubation period that a shallow lining is formed among the soft tufts of moss of the tundra on which the eggs repose. In one case such a nest-lining had the following dimensions: length, 18 cm., width 16 cm., depth 4 cm.; for the most part this lining is oval and its inner portion consists of a small quantity of dry lichen. On one occasion I found a nest of a Long-tailed Jaeger the deeper part of whose nest-lining was water-soaked and in which there was one egg quite unincubated and probably even dead, which did not prevent the bird from sitting upon it. It appears that the two sexes take part in incubation and relieve each other, at least during the time that one of the birds sits the other remains in the vicinity occupying some observation post on a neighboring hillock. From afar off, again, this sentinel gives vent to cries of alarm which warn the sitting bird to leave the nest immediately. It is only when the enemy has withdrawn to a sufficiently great distance that the two birds return to the vicinity of the nest, the one to take up again his observation post and the other to return unseen to the nest. But if by chance you should approach the place where the eggs lie, the two parent birds, quiet hitherto, commence attacking you violently; each bird in turn rises high and dives down upon the enemy with closed wings. So impetuous and menacing are the attacks of the birds that one involuntarily seeks to defend his head from the coming blow. But at the critical moment the bird swoops up and renews the attack from another side. The bird attacks in such a violent manner that sometimes it does not succeed either in stopping itself or in turning aside in time to avoid, for example, a blow with a stick; Dr. Walter once killed a Jaeger with the butt of his rifle. When the bird realizes that its attacks are unsuccessful and if the enemy continues to approach its nest, it then changes its tactics. It alights upon the ground at some distance off and simulates a wounded bird, giving vent to harsh screams, limping and beating its wings upon the ground and even lying flat upon the ground; in a word it does all that is possible to attract the attention of the enemy to itself and draw him away from the nest.

The Jaeger makes the same violent attacks upon its fourfooted enemies as well and, as Birula observed, sometimes succeeds in driving the Arctic foxes from the vicinity of the nest.

Eggs belonging to nine sets, brought back by the Russian Polar Expedition, do not differ at all in their coloration from eggs taken in other countries and they measure as follows:

1. Two eggs, slightly incubated, 3 July 1901, west shore of Taimyr Strait (Dr. H. Walter): 59 mm. x 39.6 (269 cg.); 59 x 39 (247 cg.).

2. Two eggs, slightly incubated, 8 July 1901, same place and collector: 55 mm. x 39.7 (265 cg.); 57.5 x 41 (272 cg.).

3. Two eggs, 2 July 1902, Island of New Siberia, New Siberian archipelago (A. Birula): 55.6 mm. x 42.2 (289 cg.); 55 x 40.5 (266 cg.).

4. One fresh egg, 27 June 1902, same locality and collector: 51.5 mm. x 37 (175 cg.).

5. One egg, date ?, same locality and collector: 50.7 mm. x 39 (205 cg.).

6. Two eggs, 2 July 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff): 56.7 mm. x 40 (275 cg.); 55.6 x 40.2 (295 cg.).

7. One egg, incubated, 23 June 1903, Bolschaja River, Island of New Siberia (M. Brusneff): 59 mm. x 39.9 (255 cg.).

8. Two eggs, 24 June 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow): 56.1 mm. x 41 (299 cg.); 55.5 x 40.6 (—).

9. One (of two) eggs, 19 June 1903, mouth of the Elijdep River, Charaulach Mountains, mouth of the Lena (M. Brusneff): 59.9 mm. x 41.2 (—).

Data as to the time of departure of the Long-tailed Jaeger from high latitudes are very few indeed and relate principally to the countries explored by the Russian Polar Expedition. In Western Taimyr (Sect. XII), Birula (1907) and Walter (1901, 1902, *et in litt.*) saw the last individuals of this species 8 August 1901, and the former of these two naturalists describes the behavior of the Jaegers before their departure as follows:

> In 1901 I made the following observations upon the departure of the Long-tailed Jaeger in Walter Bay. On one of the hills of the east side of the Bay, not far from our tent, on the morning of 7 August, there gathered an extraordinary number of Long-tailed Jaegers. Among them could be seen a considerable number of birds still in moult which had not yet regrown their long tail-feathers; but the young birds in brownish plumage were altogether absent. It appears therefore that the company was composed exclusively of adult birds. These were stationed in part on the tundra, in part they were flying about in different directions at no great height, giving vent to their harsh screams. Occasionally some of them stopped in their flight and while hovering in the manner of Falcons examined the ground below them. This concourse of birds was continued also on 8 August, but the next day the tundra, which the day before had resounded with the cries of scores of birds, had become altogether silent and during the remainder of my stay on the coast of Western Taimyr I was not again able to observe either the Long-tailed Jaeger or the Parasitic Jaeger. Evidently both species had left these latitudes at about the same time.

It appears, however, that the Long-tailed Jaegers do not always leave the coasts of the Siberian Arctic Ocean quite so soon, for Middendorff (1853) observed them in Taimyr as late as 4 October 1843, and Dr. Bunge (Bull. Acad. Sci. St. Pétersbourg, vol. 28, p. 530, 1883) noted them at the mouth of the Lena up till 6 September 1882. On the

Island of New Siberia Birula saw the last Long-tailed Jaeger on 19 August 1902 and Kolchak (*in litt.*) saw the last one on 2 October 1903 near Camp Michailow on Kotelny Island. The "Fram" (Collett and Nansen, Norw. North Polar Exp., p. 49, 1899) recorded the presence of a Jaeger on 4 September 1895 in north latitude 84° 47′ and east longitude 77° 17′, which Scott-Hansen identified as *Stercorarius longicaudus* (Vieillot).

LARIDAE.

Larus marinus Linné.—The Great Black-backed Gull breeds along the coast of the western portions of the Eurasian tundra and does not regularly go beyond Jugor Strait. Of observations made beyond that strait there is only the statement of Popham (Ibis, 1897, p. 106) concerning its presence at the mouth of the Yenisei which seems to me worthy of credence, for this explorer is unlikely to have confused *Larus marinus* Linné with the eastern dark-backed Gull, *Larus argentatus taimyrensis* Buturlin, which was well known to him. All other records made in the latitudes of the Siberian coast of the Arctic Ocean from Jugor Strait to Bering Strait are probably founded on inexact observations and sight identifications. Between the mouth of the White Sea and the delta of the Ob, this species, on account of its dark mantle, may readily be confused with *Larus argentatus antelius* Iredale; in the delta of the Yenisei with *Larus argentatus taimyrensis* Buturlin; and in the region of the Chuckche peninsula with *Larus schistisagus* Stejneger, as Nelson has done (Cruise of the Corwin, p. 107, 1883).

The Great Black-backed Gull has not hitherto been found in Spitzbergen (Sect. I), but at Bear Island (Sect. II) Professor König (Avif. Spitzb., p. 195, 1911) obtained an adult male 11 June 1908. The Oxford Expedition (Jourdain, Ibis, 1922, p. 173) saw two pairs there in 1921, and on 19 July secured an adult pair and two large downy young at Walrus Bay. On the Murman coast (Sect. III) it is found along shore from Varanger Fjord to the mouth of the Ponoj River and regularly breeds there,—in the western portions probably in greater abundance, in the eastern parts in smaller numbers (Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903 (in Russian); collection of our Zoölogical Museum, two males taken by the Scientific Expedition for the Exploration of the Murman Coast, under the direction of N. Knipowich, at the Ainowski Islands; Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 268, 1902). Smirnow (Compt. Rend. Acad. Sci. U. R. S. S., 1926, p. 33) has observed 7 April 1924, a single specimen and 19 April a pair under 67° 51′ north latitude and 42° 25′ east longitude in the mouth of the White Sea (between Sect. III and Sect. IV). For the Kanin peninsula (Sect. IV), Seebohm records this species on the basis of notes furnished by Henke, but the identification cannot by any means be regarded as sufficiently accurate. The records of Zitkow and Buturlin of the occurrence of this species at Kolguev Island (Sect. V) are incompletely substantiated, but Fedossow (The Game and Fish Hunter of Ukraine, 1926, no. 6, p. 45, no. 7, p. 29 (in Russian)) succeeded in the last days of July 1921 in obtaining a specimen at Bugrin Harbor. In the region about the mouth of the Pechora (Sect. VI) it is recorded as unquestionably nesting along the shores of the Arctic Ocean and probably also in the northern portions of the river's course. On Vaigach Island (Sect. VII) it is known as a breeding bird; from Nova Zembla (Sect. VIII) we have no observations of it; while for the Franz Josef archipelago (Sect. IX) it is given without comment as an accidental visitor. In Collett and Nansen's work (Norw. North Polar Exp., p. 47, 1899) we find the statement that on 30 June 1895, a dark-mantled Gull was seen and missed by the hunter to the northeast of the Franz Josef archipelago under 84° 35′ of north latitude and 75° east longitude. Finally in the lists of birds of the Kara Sea and of the mouths of the Ob (Sect. X) and the Yenisei (Sect. XI) the Black-backed Gull is included doubtfully and only Popham's observations in 1895 (1897) seem to us indubitable.

It only remains to enumerate the data of Goebel as to the times of arrival and breeding of this species on the Murman coast. At Yeretiki it appeared 26 April 1882, 20 April 1884, 21 March 1896, 28 April 1899, and 12 April 1900 (Goebel, Ornith. Jahrb., vol. 12, p. 215, 1901). As to dates of laying eggs, Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 127, 1903 (in Russian)) states that whether or

not the season is favorable in different years the sets of eggs of the Black-backed Gull are complete about 14 and 15 May. In 1899 and 1900, when the spring seasons were late, the first complete sets were found at Yeretiki 15 May; in the favorable spring of 1883, the eggs found on 18 May were incubated nearly three days and in 1901 the eggs were fresh, 14 May. In a set found by Kapustin, 2 June 1920, near Yokanga, the three eggs were heavily incubated (specimens in our Museum).

Larus schistisagus Stejneger.—The only specimen of this Gull from the region of the Eurasian tundra was obtained by the Corwin Expedition in the vicinity of Herald Island (Sect. XX, b) (see Ridgway, Bull. Nuttall Ornith. Club, vol. 7, p. 60, 1882; Nelson, Cruise of the Corwin, p. 107, 1883, under *L. marinus* Linné, *teste* Baird, Brewer and Ridgway, Water Birds of No. Amer., vol. 2, p. 229, 1884).

Larus fuscus fuscus Linné.—Of the entire region of the Eurasian tundra the Lesser Black-backed Gull inhabits only Russian Lapland (Sect. III) where it nests not only along the Murman coast, but also on the larger lakes of the interior (Lakes Imandra and Kolosero). According to Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) it arrived at Yeretiki (western part of the Murman coast), 30 March 1896, 1 May 1899, and 9 April 1900; and a fresh set of eggs was found at the same place 26 June. At the mouth of the Yenisei (Sect. XI) a straggler was killed by Popham (Ibis, 1897, p. 106) and identified by Howard Saunders.

Larus argentatus omissus Sushkin.—A revision of the palearctic forms of Gulls, appertaining to the groups of *Larus marinus* Linné, *Larus fuscus* Linné and *Larus argentatus* Pontoppidan, newly undertaken by Professor P. Sushkin and his assistant B. Staegmann, in which these gentlemen kindly permitted me to take part, has convinced us that the typical form, *Larus argentatus argentatus* Pontoppidan, inhabits western Europe only, while the birds of the Gulf of Finland, the White Sea and the Murman coast are referable to an hitherto undescribed form differing from the typical one in larger dimensions, darker mantle and different shape of the white pattern on the first primary; the legs of this subspecies are sometimes flesh-colored, sometimes yellow. Professor Sushkin is in course of preparing a detailed article upon the mentioned forms of palearctic Gulls, and will point out the differences in the dimensions and the tints of coloration of these forms. I can therefore limit myself to stating that the new form of Herring Gull, of all the Eurasian tundra region, occurs as a regularly breeding bird on the Murman coast (Sect. III) only. In greater quantity it must reach the Murman coast for wintering from its breeding places on the islands and shores of the White Sea, especially from the Solovetzky Islands, where it breeds in a half-domesticated state in countless numbers. This statement is proved by the communication of Smirnow (Comptes Rend. Acad. Sci. U. R. S. S., 1926, p. 33) who observed on 27 April 1924 numerous Herring Gulls drifting with sealers and their hunting-ships along the Murman coast in the vicinity of Nokujeff Island, intending to reach the more southern breeding places. Elsewhere in the tundra region a single specimen in immature plumage was found 13 July 1908 by Professor König (Avif. Spitzb., p. 189, 1911) at Bear Island (Sect. II). This specimen probably must be referred to the *Larus argentatus omissus* Sushkin.

Larus argentatus antelius Iredale.—The above-mentioned revision has shown moreover: (1) that the plastic characters of *Larus fuscus* Linné (especially the very elongated shape of the wing) are quite different from those of the dark-mantled oriental Gulls, designated in the last monograph of Dwight (The Gulls [Laridae] of the World, Bull. Amer. Mus. Nat. Hist., vol. 52) as *Larus fuscus taimyrensis* Buturlin (*antelius* Iredale being considered as a synonym of *taimyrensis*) and *Larus taimyrensis taimyrensis* Buturlin; (2) that these two forms of Gulls in their plastic characters agree much more closely with the group of *Larus argentatus* Pontoppidan than with the *Larus fuscus* Linné group and therefore must be considered as subspecies of the first and designated as *Larus argentatus antelius* (Iredale) and *Larus argentatus taimyrensis* Buturlin; (3) that the specimens of the large series of dark-mantled Gulls from the valley of the lower Yenisei belonging to the magnificent Tugarinow collection (which includes also the types of *Larus affinis taimyrensis* Buturlin) are really different from the dark-mantled Gulls inhabiting regularly in the breeding season the lower courses of the rivers North Dwina, Pechora and Ob; and that the birds originating from the lower Yenisei have their mantles of a uniform but clearer

tint and never attain the dark tints of the birds coming from the rivers enumerated; (4) that in the *Larus argentatus taimyrensis* Buturlin the tint of the mantle approaches very closely the tint of the darkest specimens of *Larus argentatus vegae* Palmén from the Chuckche peninsula; (5) in my opinion this form might be considered as of hybrid origin, the result of interbreeding long ago between *Larus argentatus antelius* Iredale of the Ob and *Larus argentatus birulai* Sushkin of the Taimyr peninsula and the New Siberian archipelago.

The tint of the mantle of the western form, *Larus argentatus antelius* Iredale, is near neutral gray (Ridgway, Pl. 53), whereas the mantles of the eastern form, *Larus argentatus taimyrensis* Buturlin, are of a clearer tint (Ridgway, Pl. 53, light and pallid neutral gray). In two cases birds of the Ob (male, 20 July 1913, Schuchja River, Beresow district, Tobolsk government—collected by Schuchow, and female, 20 July 1897, Samoyede camp of Langiwoshe, Ob River—collected by Derjugin) have mantles of a light neutral gray and must therefore be considered as belonging to the subspecies *Larus argentatus taimyrensis* Buturlin. But as these two specimens are in immature plumage, thickly speckled with brown, they, in my opinion must be considered as stragglers not breeding in this year, which have not attained in spring migration their habitual breeding grounds.

The breeding range of *Larus argentatus antelius* Iredale extends from the lower course of the North Dwina, Kolguev Island (Sect. V), the lower Pechora (Sect. XI) to the lower Ob and its northern tributaries (Sect. X). In the adjacent parts of the shores of the Arctic Ocean this Gull is probably only an accidental straggler, for the most part birds in immature plumage, not yet nesting. In Russian Lapland (Sect. III) Smirnow (Ornith. Jahrb., vol. 12, p. 203, 1901) observed this Gull during the spring cruise of the "Pomor," 2 April, near Swjatoi Nos and 6 April 1901, at the Yokanski Islands; from these observations it must occasionally winter there. On Kolguev Island (Sect. V) it is noted by all the explorers as regularly breeding. It remains only to add that a young bird, now in our Zoölogical Museum, was brought back from Nova Zembla (20 September, Matochkin-shar) by Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 310, 1908) and this Gull was twice observed by Gorbunow (*in litt.*): once, 26 August 1923, at the Puchowoi Bay and a second time, 16 September 1925, in the Petuchow-shar and in the Kara gates.

The Russian Polar Expedition did not meet with this Gull.

19. **Larus argentatus taimyrensis** Buturlin.

Larus fuscus, Larus marinus, Larus affinis? Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 327, 1901.

Larus fuscus. Toll, Die russ. Polarf. d. "Sarja," pp. 79, 315, 1909.

The eastern subspecies of the darker-mantled Siberian Herring Gull inhabits during the breeding season the northern parts of the woodland zone and possibly also the subalpine regions of the lower Yenisei (Sect. XI) and the Taimyr peninsula (Sect. XII and XIII) and frequents the tundra region and the shores of the Arctic Ocean outside the breeding season only. Relict breeding colonies are found in the Steppes of Baraba and of the Kirgisses. From the Eurasian tundra it is recorded as a straggler from the lower Ob (Sect. X) (Schuchja River, Tolobsk Government—collected by Schuchow; and Samoyede camp "Langiwoshe"—collected by Professor Derjugin), regularly in the mouth of the Yenisei (Sect. XI) by Seebohm, Popham, Ostrowskich and Tugarinow and at Dickson and Middendorff Bays in the autumn of 1900 by the Russian Polar Expedition (Walter, 1901). In the more southern parts of the Taimyr peninsula, at the frontier of the tundra, Middendorff succeeded in 1843 in ascertaining the breeding of this Gull at the

Boganida and the Taimyr Rivers (specimens in our Museum). From the tundra region of the Taimyr peninsula (Sect. XII), in the vicinity of the "Sarja's" first winter-quarters, no specimen of this Gull was brought back by the Russian Polar Expedition, for the unique female recorded by Dr. Walter as *Larus affinis?* turned out to be a *Larus argentatus birulai* Sushkin. Though Birula insists that two different forms of Herring Gull were observed in the Taimyr peninsula in 1901 during the breeding season, I suppose that the specimens observed by him, as also in the observation on 14 June 1901 by the late Baron Toll (1909), were only accidental stragglers from their breeding places, situated in the more southern parts of the peninsula. Finally I have to record that it breeds in the basin of the Chatanga (Sect. XIII), where Tolstow obtained a specimen in 1905 at Lake Essei and Czekanovski in 1874 another on the River Monjero, tributary of the Chatanga (specimens in our Museum).

I have no data at hand as to the time of the periodical phenomena of this Gull.

20. Larus argentatus birulai Sushkin.

Larus affinis (?), *Larus argentatus*. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901.
Larus affinis (Reinhardt). Walter, *ibid.*, vol. 16, no. 5, p. 238, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 159, 1902.
Larus cachinnans Pallas var. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 7, 47, 1907.
Larus vegae Palmén. Birula, *ibid.*, pp. 3, 9, 11, 19, 52, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult male, 13 June 1901 (a specimen intermediate in the coloration of its mantle between *Larus argentatus taimyrensis* Buturlin and *Larus argentatus birulai* Sushkin, and representing perhaps a hybrid between the two subspecies?); adult female, 1 July 1901, west coast of Taimyr Strait (Dr. H. Walter); adult female, 8 June 1902, Kotelny Island (Dr. V. Katin-Jartzeff); adult female, 27 June 1902, Ogrin peninsula, Kotelny Island (Dr. V. Katin-Jartzeff); adult male, 2 July 1902, adult male, 7 August 1902, male (?) adult, 18 August 1902, all from Island of New Siberia (A. Birula); adult male, 8 June 1902, adult female, 3 June 1902, Elijdep promontory, mouth of the Lena (M. Brusneff); adult, 24 June 1901, between Faddejefski and Kotelny Islands (O. Cionglinski); adult, 2 September 1901, Camp Michailow, Kotelny Island (O. Cionglinski).
Skeletons: one from Kotelny Island (Dr. V. Katin-Jartzeff); four from Island of New Siberia (A. Birula).
Eggs: two sets of three and two eggs respectively, 1 July 1901, west shore of Taimyr Strait (Dr. H. Walter); three, 27 June 1902, Ogrin peninsula, Kotelny Island (Dr. V. Katin-Jartzeff); one, 1902, North Cape, Nerpalach (Dr. V. Katin-Jartzeff); two, 12 June 1902, Kopto-ary, Kotelny Island (A. Kolchak).

Local names: in Samoyede, on the Taimyr peninsula, *mu moon sonnŏ* (Middendorff); in Yakut, *chopto* (Bunge) or *kopto;* in Tunguse, *kular* (Birula).

The revision mentioned above of the Gulls by Professor Sushkin has shown that *Larus argentatus vegae* Palmén must be subdivided into two separate subspecies. The western of these forms, with a lighter tint of the mantle, named *Larus argentatus birulai* Sushkin, inhabits alone Western and Eastern Taimyr (Sect. XII and XIII), Nicholas II

Land (situated to the north of Cape Cheljuskin) (Sect. XII), the shores of the Arctic Ocean at the mouths of the rivers Anabara, Olenek, Lena (Sect. XIV) and Yana (Sect. XV), the whole New Siberian archipelago (Sect. XVI) and, in company with the true, darker-mantled eastern form, *Larus argentatus vegae* Palmén, the mouth of the Kolyma (Sect. XIX), the Chukche peninsula (Sect. XX) and in winter, Japan.

Professor Palmén, when he was working out the ornithological collections of the "Vega" Expedition, noted on the labels the difference in the tint of the mantles of his types of *Larus argentatus vegae* from the Chukche peninsula and the specimens of Herring Gulls collected in 1843 at the Taimyr peninsula by Middendorff, but has not paid sufficient attention to this fact. The mantles of the western form are of a "pale gull gray," whereas the tint of the eastern form has a tendency toward "pallid neutral gray" (Ridgway, Pl. 53).

Nansen (Collett and Nansen, 1899) believes he observed Gulls, belonging probably to the western subspecies, 21 August 1893, at the Kjellman Islands, opposite the western coast of the Taimyr peninsula (Sect. XII). In the same latitudes this Gull was recorded by the members of the Russian Polar Expedition, notably by the late Dr. Walter (1901) and Birula (1907), 14 and 21 September 1900 during the stay of the "Sarja" in Middendorff Bay and on 26 September in Taimyr Strait. During the year 1901 this Gull, according to the observations of these naturalists, nested in considerable quantity in the neighborhood of the first winter-quarters of the vessel. A big male, killed by Dr. Walter, 13 June 1901, had his mantle of an intermediate tint between that of *Larus argentatus taimyrensis* Buturlin and the typical tint of the *Larus argentatus birulai* Sushkin and can therefore be considered as a hybrid between the two subspecies under consideration. A good number of specimens of this form (preserved in our Museum) were brought back from various parts of Taimyr Land by the expedition of the late Academician Middendorff; one of these specimens shows also the characters of hybrid origin (16 June 1843, Taimyr River). Two specimens of this Gull were collected on Nicholas II Land (Sect. XII), discovered by the Hydrographic Expedition to the Arctic Ocean in the north of Cape Cheljuskin (preserved in our Museum). All the specimens brought back by Dr. Bunge (Mél. Biol., vol. 12, no. 1, p. 31–107, 1885) from the mouth of the Lena (Sect. XIV) and mentioned in his writings as *Larus argentatus*, as well as a young bird recorded as *Larus glaucus*, are referable to *Larus argentatus birulai* Sushkin, as are also the Gulls noted by the same explorer from the mouth of the Yana (Sect. XV) and the Ljakoff Islands (Sect. XVI).

At the mouth of the Lena the auxiliary expedition led by M. Brusneff collected a male of this species on 8 June 1902 and a female on 3 June 1902, on the Elijdep promontory and Birula (1907) tells us that it is common along the Siberian coast about the mouths of the

Omoloi, Yana and Indigirka Rivers (Sect. XV and XVIII). From the New Siberian archipelago (Sect. XVI) comes a specimen in our Zoölogical Museum killed 19 August 1912 on Wassiljefski Island by the Hydrographic Expedition to the Arctic Ocean. This archipelago seems to be inhabited regularly and in considerable abundance by this Gull. The Russian Polar Expedition found it in various parts of Kotelny Island (Dr. Walter, *in litt.;* Birula, 1907, *et spec. coll.*), in the Island of New Siberia (Birula, 1907, *et spec. coll.*), in Faddejefski Island (Kolchak, *in litt.;* Birula, 1907) and finally, according to Kolchak (*in litt.*) the under-officer Begicheff has observed this Gull on Great Ljakoff Island. I suppose also that one of the five species of Gulls noted by the late Baron Toll (1909) for Bennett Island (Sect. XVII) represents *Larus argentatus birulai* Sushkin. In the record of Buturlin (Ibis, 1906, p. 133) from the mouth of the Kolyma (Sect. XIX) the subspecies is not defined; but the large series of Herring Gulls in our Museum from different parts of that river, shows both subspecies in nearly equal quantity. Finally from Chaun Bay (Sect. XXI) on the north coast of the Chuckche peninsula our Museum possesses a specimen, taken by the Hydrographic Expedition to the Arctic Ocean. I am not in a position to solve the question if the *Larus argentatus birulai* Sushkin breeds regularly on the Kolyma or if this river is frequented only by immature birds, not yet breeding.

Data as to the periodic phenomena of this Gull are rather few. Its arrival has been reported on the following dates:

Locality	*Date*	*Explorer*
West part of Taimyr peninsula (Sect. XII)	7 June 1901 (solitary bird)	Birula (1907, sub *L. cachinnans* Pallas var.)
do do	11 June 1901 (solitary bird)	Dr. Walter (1902, *et in litt.*, sub. *L. affinis*)
do do	13 June 1901 (numbers)	do do do
Taimyr peninsula	16 June 1843	Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 242, 1853, sub *L. argentatus*)
Nerpalach, Kotelny Id. (Sect. XVI)	8 June 1902	Dr. Katin-Jartzeff (*in litt.*)
Island of New Siberia do	6 June 1902	Birula (1907)
Faddejefski Id. do	in 1902 much earlier	do
Adshergaidach (Sect. XV)	18 May 1903	Lieut. A. Kolchak (*in litt.*)
Great Ljakoff Id. (Sect. XVI)	26 May 1903	Quartermaster Begicheff (A. Kolchak, *in litt.*)
Chuckche peninsula (Pitlekaj) (Sect XXI)	24 May 1879	"Vega" Expedition (Palmén, 1887)

From these dates we may draw the following conclusions: normally *Larus argentatus birulai* Sushkin, arrives in the region of the Eurasian tundra about the first week in June, but in some years it appears earlier (as in 1903) or it is a little later (as in 1843).

Birula (1907, p. 49, under *Larus cachinnans* Pallas var.) in his classic work on the bird-life of the arctic portions of the Siberian coasts draws for us the following picture of the manner of nesting of *Larus argentatus birulai* Sushkin:

The Herring Gull of Taimyr begins nesting immediately upon its arrival there. The first nest, containing two eggs, was found 29 June 1901. Since the nests of this Gull are in danger in these latitudes from only that arch thief of the tundra, the arctic fox (and perhaps at times from the wolf which invades the tundra following the herds of wild reindeer), it has found out a most ingenious method of placing its nest in security from the attacks of this robber. It selects as a situation for its nest, some erratic boulder with a flat top, such as occur abundantly in the tundra, and which may perchance be found in the middle of some small tundra pond. Toward the beginning of the nesting season of this Gull all the low places of the tundra are filled with icy water and are transformed into pools that are shallow though sometimes of considerable extent, which makes it easy for the Gull to find some small lake of a suitable nature. In the latter part of summer during my excursions along the north coast of the Gulf of Taimyr, I have many times seen such lakes with nests of this Gull. Occasionally a single lake had two or three such boulders, each crowned with a nest. Some of these boulders carried two nests, one of which was old and partly destroyed. Obviously a single boulder was inhabited by only one pair at a time. The nest that was visited on 1 July 1901 was built in the midst of a small lake or rather a low place filled by the melting of ice at a distance of a kilometer from the south coast of the "Sarja's" anchorage. This pond was 500 paces wide and about 700–800 long; its depth nowhere exceeded an archine (91 centimeters) so that one could wade about everywhere with hunting boots. The bottom, however, was frozen, and probably had been so since the autumn previous, so that the water had simply submerged it. The shores of the lakelet, especially the north shore, were low and muddy, a black mass of turf, abundantly mixed with the excrement of Geese as well as their moulted wing- and tail-feathers. Evidently in summer this plain served as a moulting place from year to year for the Brent Geese. Certain parts of the shore were strewn with erratic boulders, and there was a considerable number in the lake itself. Around the latter the snow had not entirely disappeared and the lake was in part a mire of water-logged snow, which in the icy water melted but slowly. On two of the boulders that rose from the midst of this mass of melting snow were placed two Gulls' nests (Plate 24, figs. 1 and 2). The boulders were at a distance of about sixty to seventy paces from the nearest shore, which not only insured the eggs a sufficient protection from the arctic foxes but bore witness to the most attentive care on the part of the Gulls toward their progeny as well as giving proof of a certain intelligence, in contrast to the other inhabitants of the tundra, the Geese, Eiders and waders. For material in construction of their nests the Gulls had made use of every available thing on the tundra. First, a hollow place on the boulder was filled with moss pulled up in tufts from the tundra, which gave the nest a soft foundation, but since the fine moss of the tundra is a material only slightly compacted and hardly affords a very solid construction, but may easily break away as it dries, the Gulls make use of the wing-feathers of Geese to bind the tufts of moss together. In arranging these feathers between the layers of moss and the tufts of reindeer hair, the Gulls had made the nests so solid that they could not be detached from the boulders without fear of injuring them. It is curious that the feathers were not arranged at haphazard, but for the most part like spokes of a wheel, the vanes toward the center of the nest and the quills to the outside. In this way the inner layer had a certain softness and in addition was lined with a small amount of down. On account of the materials of which the nests were made, they lacked neatness because their exteriors were pierced in all directions by the quills of the goose feathers, but this essential point was attained—that they were sufficiently compact and the eggs were in full security.

When we arrived at the lake the Gulls at once left their nests and began to fly about over our heads, screaming. It should be added, however, that only two of the Gulls showed signs of distress and continued to fly about over us, while the other two flew off to some distance and, alighting upon some boul-

ders, stood gazing at us with more or less indifference. We succeeded in shooting the two birds nearest us and one of those that had withdrawn from the lake. All three showed bare patches from incubation. The two first were males while the one that had not stayed to defend its nest was a female. I do not attempt to draw from this one observation any general conclusion as to the biology of the species, but I find the fact to be of such interest as to deserve mention.

In addition to the manner of nesting just described, the Gull probably has another method, namely, of making its nests on islands in the lakes. In the latter case, it appears, they associate more in colonies in company with two other species of Taimyr Gulls of the genus *Larus*. Such a nesting place was found on Taimyr Island. On the south coast of this island there is a lake of rather large size and of different origin from the small tundra lakes just described, formed from snow water. However, this lake was likewise almost completely filled with water from melted ice, and was of a depth of not over two archines. At some distance from the shore of this lake was a rocky islet covered with an abundance of Gulls' nests, like a miniature gull rock.

The conditions under which *Larus argentatus birulai* Sushkin breeds among the islands of the New Siberian archipelago are rather different from those thus described by Birula for Western Taimyr. On 16 July 1902 Naval Lieutenant A. Kolchak found in Bunge Land (Kotelny Island) a nest of this species which as yet contained no eggs. It was built on a slightly elevated bank of sand among driftwood cast up by the sea. The nest was a slight depression lined with moss. The same explorer on 17 June 1902 visited Koptoloch-ary (Kotelny Island)—which signifies "Isle of Gulls"—and gives (*in litt.*) the following account of the Gull colony that he found there:

The "Isle of Gulls" is a flat low islet, covered by tundra interspersed with pools of water, some 200–300 sagens (472–640 meters) square. Its shores are covered by a considerable quantity of decayed driftwood. On its southern portion nest large quantities of Gulls, numbering several hundreds. The nests were all made in the same manner and for the most part placed in dry situations, among the still unmelted snow-drifts. The nests were depressions surrounded by a ridge of moss, bits of decayed wood, and goose feathers. From the side, the nest presented the appearance of a truncated cone, with a hollow in the center.

As for data on the breeding of this Gull, they are even fewer than those on its arrival on its nesting grounds. The eggs found by Dr. Walter and Birula in the vicinity of the first winter-quarters of the "Sarja" on the Taimyr peninsula were but slightly incubated 29 June 1901. This date corresponds very closely with the finds made: (1) by Brusneff of a set 23 June 1903 on the Roshin promontory, Island of New Siberia (Birula, 1907); (2) by Dr. Katin-Jartzeff, of a non-incubated set 24 June 1902 on the Ogrin promontory, Kotelny Island; and (3) by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 130, 1887) of a slightly incubated set on 23 June 1884 at Sagastyr, mouth of the Lena, and of a slightly incubated set 6 July 1886, on Great Ljakoff Island (*ibid.*, p. 179, 1887). The young birds began to fly on the Island of New Siberia in August (28 August 1902—Birula, 1907) but were still tended by the parent birds.

The Russian Polär Expedition brought back in all four complete sets of eggs of this Gull and two other eggs belonging to different sets.

1. 1 July 1901, west shore of Taimyr Strait (Dr. H. Walter—No. 65, under L. affinis).—This set of three eggs belonged to the nest described by Birula (1907). The ground color in the three eggs is considerably different: the egg designated by the letter *A* has the ground color brownish (Ridgway, Pl. 40, wood brown) and is covered with large deeper blotches of a grayish color and more superficial ones of a clove brown (Ridgway, Pl. 40); egg *B* has drab-brown ground (drab of Ridgway, Pl. 46) and is blotched like the preceding; egg *C* has a dark olive ground (Ridgway, Pl. 40, deep olive buff), the spots very small, and those of a clove brown tint very few in number. The eggs measure: 66 mm. x 46.1 (560 cg.); 69.5 x 45.3 (597 cg.); 69.2 x 47.5 (587 cg.).

2. 1 July 1901, same locality and collecior as the preceding (No. 66).—The two eggs of this set differ very obviously from those of the preceding. Both have the ground color of a nut brown (Ridgway, Pl. 40, avellaneous), the larger and deeper spots are of a light mouse gray (Ridgway, Pl. 51), the superficial spots, also numerous and large, are for the most part of a smoky brown (Ridgway, Pl. 46, chaetura black) and those of egg *B*, in part brown (Ridgway, Pl. 40, natal brown). The eggs have the following dimensions: 75 mm. x 50.1 (628 cg.); 73.2 x 51 (620 cg.).

3. 27 June 1902, Ogrin peninsula, Kotelny Island (Dr. V. Katin-Jartzeff) (see Pl. 23, fig. 2).—The three eggs of this set have the ground of an olivaceous chamois (Ridgway, Pl. 40, olive buff). Eggs *A* and *B* have a slight tinge of wine-color. The deeper spots are of a dark olive gray (Ridgway, Pl. 40) and the superficial spots in part of a clove brown and in part almost a dull black. The eggs have the following dimensions: 75.8 mm. x 50.5 (660 cg.); 75 x 50.1 (682 cg.); 71.3 x 51.2 (712 cg.).

4. 27 June 1902, Severny promontory, Nerpalach, Kotelny Island (Dr. V. Katin-Jartzeff).—The single egg of this set has a ground color altogether different from all the others. It is of a bluish gray and at the same time yellowish (Ridgway, Pl. 41, yellowish glaucous); the deeper blotches are of a light mouse gray and the more superficial ones are brownish (Ridgway, Pl. 40, natal brown). It measures: 72.5 mm. x 52.5 (673 cg.).

5. 17 June 1902, Koptoloch-ary, Kotelny Island (Lieut. A. Kolchak).—Naval Lieutenant A. Kolchak collected on Koptoloch-ary eighty eggs of Gulls, of which he prepared four from different sets. He supposed that all these eggs belonged to *Larus argentatus birulai* Sushkin; however, two of them from their measurements and weights unquestionably appertain to *Larus glaucus* Brünnich (=*hyperboreus* Pontoppidan). These eggs resemble each other closely though coming from different sets. The ground color is deep olive buff (Ridgway, Pl. 40); their superficial spots are notable for their size, and are in part of a dark olive-gray tint and in part of a clove brown. The blackish spots are very few. The eggs measure: (*A*) 68.4 mm. x 51 (694 cg.); (*B*) 71.5 x 49.8 (679 cg.).

The departure of this Gull from its breeding grounds takes place in the latter half of September. In 1900 the last birds were seen by the members of the Russian Polar Expedition in Kolomeitzeff Bay, west shore of Taimyr peninsula, 20–21 September. At Sagastyr, mouth of the Lena, Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 600, 1883) noted the last ones 12 September; in 1901 these Gulls left Nerpalach Bay, Kotelny Island, 26 September, and the Island of New Siberia on 21 September 1902 (Birula, 1907).

The most northerly point of the habitat of *Larus argentatus birulai* Sushkin, as far as at present known, is in Emperor Nicholas II Land, between 77° 50′ and beyond 80° north latitude.

Larus argentatus vegae Palmén.—*Local name:* in Chuckche, *ammunkin yayak, yayak* (Palmén). As I have pointed out in the article upon the preceding subspecies of Herring Gull, the eastern, darker form, described by Professor Palmén from the Chuckche peninsula as *Larus argentatus vegae*, inhabits the basin of the Kolyma River (Sect. XIX) in company with the western form—*Larus argentatus birulai* Sushkin. From the north coast of the Chuckche peninsula (Sect. XXI) come the original specimens of the subspecies taken in the vicinity of the "Vega's" winter-quarters in 1878–79 (Palmén, 1887) as well as those taken by the Hydrographic Expedition to the Arctic Ocean (specimens in our Museum) and by the Corwin Expedition (Nelson, Cruise of the Corwin, p. 107, 1883, under *L. affinis* Reinhardt and *L. cachinnans* Pallas). The subspecies of Herring Gull, of which Koren (Thayer and Bangs, 1914) took eggs at the mouth of the Kolyma and which he observed also at Cape Baranowski is not sufficiently determined. According to the collections of our Museum the typical *Larus argentatus vegae* Palmén is rather numerous on the eastern shores of the Chuckche peninsula and in the basin of the Anadyr. We have also a specimen from Kenai in Alaska, collected by Wosnessenski in the year 1844, probably a wintering bird.

The Vega Herring Gull appeared 24 May 1879 at Pitlekaj on the Chuckche peninsula and sets of eggs were obtained 13 and 21 July 1879 at Pitlekaj and 14 July 1879 at Tjapka (Palmén, 1887).

The Russian Polar Expedition did not meet with this Gull.

Larus canus canus Linné.—The breeding area of the Common Gull lies in the latitudes south of the Eurasian tundra and only reaches the latter on the Murman coast of Russian Lapland (Sect. III) and on the Kanin peninsula (Sect. IV). Lawrow (Mém. Soc. Nat. Kasan, vol. 41, no. 4, p. 17, 1909, in Russian) identified solitary individuals of this Gull at the mouth of the Yenisei (Sect. XI), and these without doubt were then outside their breeding period. This species has also been recorded in a preliminary report by Dr. Walter (Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901) from Western Taimyr but I cannot attribute any importance to this statement, seeing that the author himself did not mention the species in his later works. The eastern form of this Gull described by Pallas, under the name of *Larus niveus* and by Bonaparte as *Larus kamtschatkensis* and which Saunders has united with the typical form, inhabits the region of Bering Sea, but evidently does not pass Bering Strait, because it has not been recorded from the northern coasts of the Chuckche peninsula.

21. **Larus glaucus** Brünnich (=**hyperboreus** Gunnerus).

Larus glaucus, Larus glaucescens?, Larus leucopterus?. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901.

Larus glaucus Fabricius. Walter, *ibid.*, vol. 16, no. 5, p. 238, 19 2; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 159, 1904. Brusneff, *ibid.*, p. 186, 1904. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1–5, 9, 12–13, 18, 45, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: immature, 10 September 1900, Middendorff Bay, Western Taimyr (Dr. H. Walter); adult, 9 June 1902, Nerpalach, Kotelny Island (Dr. V. Katin-Jartzeff); adult, 12 August 1901, Camp Michailow, Kotelny Island (O. Cionglinski); adult male, 11 September 1902, Island of New Siberia (Birula); adult female, 31 August 1903, Cape Wysoki, Island of New Siberia (M. Brusneff); adult female, 17 August 1902, Bykow peninsula, mouth of the Lena (M. Brusneff); two young in down, 22 July 1902, Nerpalach, Kotelny Island (Dr. V. Katin-Jartzeff); two young in down, 4 August 1902, Bielkovski Island, New Siberian archipelago (Dr. V. Katin-Jartzeff).

Skeletons: Kotelny (Dr. V. Katin-Jartzeff); New Siberia (Birula).

Eggs: three, 26 June 1902, Ogrin peninsula, Kotelny Island (Dr. V. Katin-Jartzeff); two, 17 June 1902, Kopto-ary, Kotelny Island (Dr. V. Katin-Jartzeff); one, between 5 and 18 July 1902, Bielkovski Island (Lieut. Matiessen).

Local names: in Russian, *kluscha* (Murman Coast); in Samoyede *har-ley-o* (Kolguev, Trevor-Battye) and *djammu-sónnŏ* (Taimyr, Middendorff); in Yakut, *kopto* (Birula) or *chopto* (Bunge, Brusneff); in Tunguse, *kulár* (Birula); in Chuckche, *yttak*, *tchikerga* (Palmén).

If we adopt the view of Saunders (Cat. Birds Brit. Mus., vol. 25, p. 292, 1896) that the *Larus barrovianus* of Ridgway (Auk, 1886, p. 330) is identical with *Larus glaucus* Brünnich, then the Burgomaster Gull represents an absolutely circumpolar form. It has been recorded from all my twenty-one sections of the Eurasian tundra region and I have not the slightest doubt that it breeds in them all, though in varying abundance according to the more or less favorable nature of the localities for nesting.

The Russian Polar Expedition met with the Burgomaster Gull in all the regions traversed beyond Jugor Strait, in all the bays of the west coast of Taimyr peninsula (Dickson Bay, Kolomeitzeff Bay, Bay of Wolves, Middendorff Bay, and the first winter-quarters of the "Sarja" (Sect. XII)—Walter, *in litt. et exempl. coll.;* Birula, 1907). No nests of this Gull have been found in the Taimyr peninsula, but Birula is of the opinion that it breeds there, more particularly because Middendorff recorded it as breeding there. I doubt not that the Gulls which Dr. Walter (1901) recorded in the same region under the names *Larus glaucescens* (?) and *Larus leucopterus* (?) but which he was unable to secure, pertain clearly to *Larus glaucus* Brünnich (=*hyperboreus* Gunnerus). When nearing Nerpalach Bay in the autumn of 1901 (between 19 and 26 September) the Russian Polar Expedition found there a considerable number of Burgomaster Gulls, especially immature birds in the gray plumage. In the summer of 1902, the species was evidently not rare in vicinity of the second winter-quarters of the "Sarja" and Dr. Katin-Jartzeff succeeded in procuring not only adult birds but two sets of eggs and some downy young as well. During the summer of the same year the species was not abundant on the Island of New Siberia, and Birula (1907) met with it there on some ten occasions only; in 1903 Brusneff found it on this same island but we have neither notes nor specimens of the bird from Faddejefski Island, and we may suppose that Quartermaster Tolstow, who spent the summer of 1903 on this island, did not see it there. Of the five species of

Gulls recorded by the late Baron Toll (1904) from Bennett Island, *Larus glaucus* was evidently one. As to observations made concerning this Gull by members of the auxiliary expeditions we may note the following: during his excursion to Bennett Island in 1903 in search of Baron Toll, Naval Lieutenant A. Kolchak observed the first Gull on 1 June, on the northwest coast of Little Ljakoff Island, and supposes that it was a Burgomaster Gull; on Kotelny Island he several times found it as well as at Cape Medweshi (southern part of the island) and near Camp Michailow, whence Cionglinski obtained for us an adult specimen killed 12 August 1901. From Bielkovski Island come two chicks, collected by Dr. Katin-Jartzeff, and one egg taken by Naval Lieutenant Th. Matiessen. From the mainland Brusneff has given us an adult female specimen killed 17 August 1902, on the Bykow peninsula, at the mouth of the Lena River.

Notes on the arrival of the Burgomaster Gull on its breeding grounds in the different parts of the Eurasian tundra region are not numerous. At Spitzbergen (Sect. I) the arrival of the first ones was noted by Sendsen, 18 February 1910 (Münsterhjelm, Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910). Dr. Bunge (Birula, Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 169, 1910) saw the first bird in 1900 on 17 April, but other members of the Expedition had already seen sundry examples on 9 April. The bulk of them did not arrive, however, until 18 May. According to Dr. Rempp (Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 112, 1913) the two first individuals appeared 26 and 27 April 1912, and Pike (Chapman, Wild Norway, p. 348, 1897) noted their arrival 26 March 1889. At Bear Island (Sect. II) these Gulls were already present according to Keilhau (Reise Ost- u. West-Finmarken, Beeren Eil. u. Spitzb., p. 130, 1831) in the month of February. Professor König (Avif. Spitzb., p. 191, 1911) is doubtful as to the correctness of this statement since birds of passage do not appear on this island, according to other explorers, until the end of March. But if we take the date of arrival of *Larus glaucus* at Spitzbergen as 18 February 1910 (Münsterhjelm, 1910) I see no difficulty in admitting the possibility of its appearance at Bear Island during the same month.

The dates given by Goebel (Ornith. Jahrb., vol. 12, p. 215, 1900) for the western portion of the Murman coast (Yeretiki Bay) (Sect. III) are not sufficiently exact. Over a course of years his dates have no value because Goebel on his arrival at Yeretiki found the Gulls already there and obviously was unable to determine the exact date of their arrival. In 1899 he did not see the first birds until 7 May and these individuals had undoubtedly been there for a considerable while already; in 1900 he noted the arrival of this species on 14 April. Smirnow (Compt. Rend. Acad. Sci. U. R. S. S., 1926, p. 33, in Russian) tells us that *Larus glaucus* winters regularly on the snow-fields of the White Sea and the adjacent parts of the Barentz Sea (between Sect. III and Sect. IV) and feeds there on the corpses of seals, abandoned by the hunters. From 8 April to 11 May flocks of ten and twelve

individuals passed in a southerly direction and were evidently on their spring migration from winter-quarters to their breeding places in the White Sea.

For Nova Zembla (Sect. VIII) we have at hand only the following dates: 11 April 1883, *Larus glaucus* appeared there according to Kriwoschcja (Nature and Hunting, no. 11, p. 39, 1884, in Russian) and Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 89) saw the first individual at Matochkin-shar, 12 May 1903. In the Franz Josef archipelago (Sect. IX) Leigh Smith noted its appearance at Cape Flora, 5 March 1882 (Clarke, Ibis, 1898, p. 264) and Jackson (A Thousand Days in the Arctic, p. 403, 1899) in mid-March 1895; though according to Dr. Koettlitz's notes it did not appear there in this year until 6 May and in 1896 on 4 April. The latter date may be regarded as quite exact, because five days later, 9 April 1896, this Gull was seen at Nansen's winter-quarters, northeast of the Franz Josef archipelago (Collett and Nansen, Norw. North Polar Exp., p. 30, 1899). In Western Taimyr (Sect. XII) the arrival of the Burgomaster Gull at the first winter-quarters of the "Sarja" was noted by the late Dr. Walter on 13 June 1901, but this date seems to me very late. At the mouth of the Lena (Sect. XIV) Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 48, 1888) noted the arrival of the first birds on 28 May 1883. At Little Ljakoff Island Kolchak (*in litt.*) saw the first Gull (which he believed to be a *Larus glaucus*) on 1 June 1903. Finally on 11 May 1879 large quantities of Gulls were seen at Idlidja Island, to the east of the "Vega's" winter-quarters (Palmén, Sibir. Ishk. Fogelf., p. 366, 1887), but it was not till 14 May that the first one was secured at Jinretlen by Dr. Almquist.

Data as to the breeding season of the Burgomaster Gull are not more detailed than the following from Spitzbergen and Bear Island while elsewhere in the Eurasian tundra they are either lacking altogether or are very few indeed. For Spitzbergen and Bear Island, however, we may draw the two following conclusions: (1) dates for the laying of eggs and consequently for the hatching of the young vary greatly from year to year, according to the better or worse conditions of the spring. Thus we see for Spitzbergen that Münsterhjelm in 1910 recorded the hatching of the two first young on 22 and 23 June, which allows us to fix the date of laying as 25 and 26 May, respectively. In 1899 and 1900 according to the observations of Dr. Bunge and of Birula, the eggs were laid twenty days later, that is, 14 and 15 June, and some even on 24 June. The same has been shown for Bear Island, for Römer and Schaudinn in 1898 found young birds there 13 June, so that the eggs must have been laid by 16 May 1898, while according to König's observations eggs were not laid in 1907 until about 6 June and in 1908 about 8 June. (2) The dates given in the table and the deductions drawn relate to the majority of sets. But independently of the normal sets, there is every year a number of late sets due probably to the loss of the first eggs. From this fact result the observations made by a consider-

Breeding of the Burgomaster Gull.

Incubation period 28 days		Spitzbergen (Sect. I)	Bear Island (Sect. II)	Mouth of the Lena (Sect. XIV)	New Siberian Archipelago (Sect. XVI)	Mouth of the Kolyma (Sect. XIX)
The set completed	Early dates	25 May 1910 [1] 26 May 1910 [1]	16 My 1898 [2]	16 Je 1883 [8]		
	Normal dates	8 Je 1908 [2] *13 Je 1908* [2] (5 days incub.) 14 Je 1900 [3] *24 Je 1900* [3] (10 days incub.) *15 Je 1900* [3] 14 Je 1899 [3]	3 Je 1907 [2] *17 Je 1907* [2] (14 days incub. 13 Je 1864 [6] *18 Je 1864* [6] (5 days incub.)	20 Je 1884 [9] *22 Je 1884* [9] (2 days incub.?)	13 Je 1902 [11] *27 Je 1902* [10] (14 days incub.?	23 Je 1912 [11] *26 Je 1912* [11] (3 days incub.?)
	Late dates	24 Je 1900 [3] *27 Je 1900* [3] (3 days incub.?)	27 Je 1899 [7] 28 Je 1899 [7]			5 Jy 1912 [11] *26 Jy 1912* [11] (20 days incub.?)
Date of hatching	Early dates	*22 Je 1910* [1] *23 Je 1910* [1]	*13 Je 1898* [5]	*11 Jy 1883* [8] 14 Jy 1883 [8]		
	Normal dates	12 Jy 1900 [3] 13 Jy 1900 [3] *12 Jy 1899* [4]	4 Jy 1907 [2] 12 Jy 1864 [6]	18 Jy 1884 [9]	12 Jy 1902 [10]	21 Jy 1912 [11]
	Late dates	22 Jy 1900 [3]	*25 Jy 1899* [7] *26 Jy 1899* [7]			2 Ag 1912 [11]

[1] Münsterhjelm, Öfv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910.
[2] König, Avif. Spitzb., p. 193, 1911.
[3] Observation of Dr. Bunge, see Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 319, 1902.
[4] Birula, *ibid.*, vol. 15, p. 169, 1910.
[5] Römer and Schaudinn, Ornith. Monatsb., vol. 8, p. 121, 1900.
[6] Malmgren, Journ. f. Ornith., vol. 13, p. 204, 1865.
[7] Swenander, Bih. Kongl. Svensk. Vet.-Akad., Handl., vol. 26, pt. 4, no. 3, p. 22, 1900.
[8] Bunge, Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 48, 1888.
[9] Bunge, Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 129, 1887.
[10] Dr. Katin-Jartzeff, *in litt.*
[11] Thayer and Bangs, Proc. New England Zool. Club, vol. 5, p. 10, 1914.

able number of explorers according to which one may find even at the end of summer young chicks in down and even fresh or slightly incubated eggs side by side with immature birds already able to fly. Römer and Schaudinn (1900) found that the greater part of the young individuals were already on the wing at Helis Sound, Spitzbergen, on 16 August, while at the same time one might still come upon downy young. At Bear Island these explorers found numerous downy young 13 June 1898, but secured at the same time an abundance of eggs, either fresh or more or less incubated. Malmgren (1865) found eggs even as late as 1 August that could easily be blown.

The Burgomaster Gulls prefer to make their nests on the tops of rocks along the sea-

shore, either the top of a *bazar* (a rock inhabited by Gulls and Guillemots) or, if these *bazars* are lacking, on the rocky parts of the seashore itself.

The specimens of adult birds, of young and eggs brought back by the Russian Polar Expedition show no special peculiarities. The eggs have the following measurements and weights:—

1. 26 June 1902, Ogrin peninsula, Kotelny Island (*Dr. V. Katin-Jartzeff*).—81 mm. x 54.2 (930 cg.); 81 x 54 (860 cg.); 81 x 55 (940 cg.).

2. 17 June 1902, Kopto-ary (*Gull Isle*), *Kotelny* (*A. Kolchak's journey*).—The two eggs are from different sets: 81 mm. x 52.5 (950 cg.); 77 x 51 (815 cg.).

At Spitzbergen and Bear Island the young begin to fly in the first part of August. The date, 21 June, given by Bianchi for this stage of the development of the young is obviously founded on some error, as Professor König has already stated in his work on the avifauna of Spitzbergen. For Nova Zembla, Schaanning has recorded the first young on 11 July 1903, and according to Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 310, 1908) the young begin to fly about 14 August.

Gorbunow (*in litt.*) informs me that he found 22 August 1925 at Cape Jelanija, the extreme northern point of the North Island of Nova Zembla, a nest with three big young, scarcely feathered. At Puchowaja Bay (South Island) the young began to fly on 20 August 1923 and they left the nesting places entirely by 1 September.

Regarding the departure of this Gull from various localities of the Eurasian tundra we have only the following notes: Birula (Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 169, 1910) states that they became rare in Spitzbergen (Sect. I) about 4 October 1899, and were quite gone by 9 October of that year, while Dr. Bunge (see Bianchi, *ibid.*, vol. 7, p. 307, 1902) observed single birds as late as 20 October 1899, and Pike (see Chapman, Wild Norway, p. 344, 1897) noted their departure from Amsterdam Island 13 October. Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903 (in Russian)) is authority for the statement that the Burgomaster Gulls winter in the open-sea portion of Kola Bay and along the eastern parts of the Murman coast (Sect. III), just as, according to Smirnow (1926), they winter in the mouth of the White Sea (between Sect. III and Sect. IV). In Nova Zembla (Sect. VIII) according to Bilkiewiez (App. Mem. Exped. Univ. Kasan, p. 18, 1904) the greater part of these Gulls disappeared by early September and about 27 September only solitary individuals were to be seen. Schaanning (1907) recorded them from Matochkin-shar in 1902 as late as 25 October. In the Franz Josef archipelago (Sect. IX) Neale observed this Gull at Cape Flora up to the end of October (Clarke, Ibis, 1898, p. 264) and Jackson's expedition (A Thousand Days in the Arctic, p. 403, 1899) noted the departure of the immature birds 16 September 1894 and their complete disappearance 24 September 1895 and 21 September 1896; while Nansen

(Collett and Nansen, Norw. North Polar Exp., p. 30, 1899) saw sundry young birds up to mid-October near his winter-quarters of 1895. Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 241, 1853) noticed the departure of the bulk of these birds from Taimyr (74° 30′ north latitude) on 15 and 16 September and of the last birds by 3 October. Last of all, at the mouth of the Lena (Sect. XIV) Dr. Bunge (Bull. Acad. Sci. St. Pétersbourg, vol. 28, p. 530, 1883) noted the last individuals 26 September.

It remains only to add that Nansen (Collett and Nansen, Norw. North Polar Exp., p. 29, 1899) discovered a nesting ground of the Burgomaster Gull on Torup Island (Coburg Island) under 81° 33′ north latitude and heard the call of a Gull, probably of this species 1 June 1895, at 82° 20′ north latitude and shot at a large Gull as far north as 84° 48′. Since no other large Gull is known to inhabit the latitudes of the Franz Josef archipelago, this last observation can refer only to *Larus glaucus* Brünnich although the identity of the individual could not be definitely determined.

Larus leucopterus Faber (=**glaucoides** Meyer).—For this species there are extremely few absolutely certain records based upon specimens; most explorers cite this species of Gull from various sections of the western and middle parts of the Eurasian tundra without being able to adduce adequate proof. I have not the slightest doubt that *Larus leucopterus* Faber, which in winter regularly frequents Iceland, the Faroe Islands and at times the coasts of the eastern Atlantic from the Gulf of Gascony to Scandinavia, may appear from time to time in the latitudes of Spitzbergen and along the Murman coast, but I know of no certain record for these countries. In the Spitzbergen region (Sect. I) the Duke of Orleans claims to have seen several individuals in 1905, but was unable to secure specimens. König (Avif. Spitzb., p. 190, 1911) regards this observation as insufficiently established and excludes this species from his list of Spitzbergen birds. For the Murman coast (Sect. III) the records are of a similar sort: Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903 (in Russian)) lists this Gull for the coasts of the Arctic Ocean in Russian Lapland and even as a summer bird in the western portions of the Murman coast, but adduces no evidence for the correctness of his determinations. During his cruise on the ship "Pomor," N. Smirnow (Ornith. Jahrb., vol. 12, pp. 203–205, 208, 209, 1901) claims to have seen the Iceland Gull in the eastern parts of the Murman coast and in sundry places in Barenz Sea and even records the finding of a nest on 16 July 1901 in Chernaja Bay, Nova Zembla, that he was unable to reach though he secured the two parent birds. V. Bianchi (Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 263–273, 1902) who studied the collections brought back by the "Pomor," found among them only specimens of *Larus glaucus* Brünnich, and no trace of *Larus leucopterus* Faber. Under these circumstances Smirnow's statements are absolutely doubtful. However, we have in addition to these records, Pelzeln's statement (Verh. zoöl.-bot. Ges. Wien, vol. 24, p. 30–31, 1874) that Count Wilzek deposited in the Zoölogical Museum at Vienna a specimen of *Larus leucopterus* Faber, coming from Nova Zembla. I was at first inclined to doubt the correctness of this identification altogether, but having found in our Zoölogical Museum an undoubted specimen of the Iceland Gull in first plumage, brought by C. Nossilow from Nova Zembla (Sect. VIII), I feel obliged to change my mind and to regard it as possible that Pelzeln's identification of the specimen from Count Wilzek's expedition was correct. The observations of Heuglin (Journ. f. Ornith., vol. 20, p. 125, 1872) made in the latitudes of Vaigach Island (Sect. VII) and Jugor Strait must be looked upon as insufficiently attested. Those of Dr. Walter of the Russian Polar Expedition, regarding the western part of the Siberian Arctic Ocean and Taimyr peninsula (see under *Larus glaucus* Brünnich), of Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 242, 1853) concerning Taimyr (Sect. XII) and of Dr. Bunge (Mél. Biol., vol. 12, p. 53, 1888) relative to the mouth of the Lena

(Sect. XIV) as well as those of Nelson (Cruise of the Corwin, p. 106, 1883) are also based on insufficient identifications, and for the most part must relate to *Larus glaucus* Brünnich and perhaps in part (as regards the north coast of the Chukchi peninsula) to *Larus glaucescens* Naumann.

Larus glaucescens Naumann.—The only evidence of the occurrence of *Larus glaucescens* Naumann on the northern coast of the Chukchi peninsula (Sect. XXI) consists of a specimen brought back by the "Vega" Expedition, that unfortunately lacks a precise label. In regard to this specimen, Professor Palmén (Sibir. Ishafsk. Fogelf., p. 309, 1887) states his opinion that in view of the lack of any indication whatever as to the "Vega" having procured it somewhere in the course of her return voyage from her winter-quarters, it is possible that it had been taken in the vicinity of Pitlekaj.

As to the statement of Buturlin (Ibis, 1906, p. 133) that this species was on passage 10 and 11 June 1905 in great numbers in the vicinity of Ust-Kolymsk, I have no hesitation in expressing my doubts as to the correctness of the identification of the Gulls observed; probably they were nothing more than *Larus argentatus birulai* Sushkin, or *Larus argentatus vegae* Palmén or *Larus glaucus* Brünnich (=*hyperboreus* Gunnerus).

22. **Rissa rissa rissa** (Linné) (=**t. tridactyla** (Linné)).

Rissa rissa (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 8, 14, **54**, 1907.

Rissa tridactyla. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 203, 1902; Die russ. Polarf. d. "Sarja," pp. 383, 397, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: two adults, 24 and 25 June 1902, Nerpalach, Kotelny Island (Dr. Katin-Jartzeff).

Local name: in Chukchi, *kakyttack* (Palmén).

The Kittiwake Gull is recorded from nearly all parts of the coasts of the Eurasian Arctic Ocean, but without doubt it inhabits the different sections of these regions in altogether varying numbers. Where it finds places suitable for nesting it is very common and breeds in enormous numbers, whereas on flat coasts without precipitous rocks, it is quite absent during the breeding period and appears but accidentally, for the most part in autumn.

According to the published records, the Kittiwake nests in the following localities within the region of the Eurasian tundra: in Spitzbergen (Sect. I) and on Bear Island (Sect. II) in enormous colonies, in great numbers along the Murman coast (Sect. III), on Vaigach Island (Sect. VII), on the two islands of Nova Zembla (Sect. VIII), in the Franz Josef archipelago (Sect. IX), on Preobraschenija Island, opposite the mouth of the Chatanga (Sect. XIII), on some of the islands of the New Siberian archipelago (Sect. XVI), notably Bielkovski Island and in a part of Kotelny Island, perhaps on Stolbowoi Island (Palmén, Sibir. Ishk. Fogelf., p. 360, 1887), on Bennett, Novopachenny and General Wilkitzky Islands (Sect. XVII), possibly in the Bear archipelago, in the latitudes of the Kolyma (Sect. XIX) (Palmén, 1887), on Wrangel and Herald Islands (Sect. XX), and according to information given by the Chukchis to the "Vega" Expedition, near Jinretlen, on the north coast of the Chukchi peninsula (Sect. XXI),

and according to Koren (Thayer and Bangs, 1914) on Koljuchin Island. On Kolguev Island (Sect. V), where the bird evidently does not breed, Fedossow (The Hunter and Fisherman of Ukraine, 1926, no. 7, p. 28–29) succeeded in shooting near the mouth of the Yurennaja River a single young specimen of the Kittiwake.

The Russian Polar Expedition met with this bird in the following localities: Birula (1907) found considerable numbers during the stay of the "Sarja" between 12 and 17 August at Dickson Bay (Sect. XI); Dr. Walter (1901) records it from Western Taimyr (Sect. XII) where it appears during its autumnal wanderings; again, Baron Toll (1909), Dr. Walter (*in litt.*) and Birula (1907) have noted single individuals and flocks opposite the mouth of the Chatanga, 4 September 1901 (Eastern Taimyr, Sect. XIII) which undoubtedly came from the colony on Preobraschenija Island. Next, the birds appeared 6 July 1902 in the vicinity of Nerpalach, Kotelny Island, where they became numerous between 11 and 13 July, and appeared in great companies between 18 and 20 August (Dr. Katin-Jartzeff, *in litt.*). A single bird was seen by Birula (1907) on the north coast of the Island of New Siberia. During the first landing on Bennett Island, 12 September 1901, Baron Toll (1909) observed one and Birula (1907) saw great quantities of adult and young birds. I believe I should mention also some records for this species made by the Hydrographic Expedition to the Arctic Ocean: the Kittiwake was identified by this Expedition on the east coast of the Taimyr peninsula (Sect. XIII), on Novopachenny and General Wilkitzy Islands (Sect. XVII), those of the group forming the archipelago of New Siberia (Sect. XVI), on Wrangel Island (Sect. XX) and on the north shore of the Chukche peninsula (Sect. XXI).

We have the following data as to the time of the Kittiwake's arrival in the different parts of the Eurasian tundra region.

In Spitzbergen (Sect. I): 18 April 1889, at Amsterdam Island according to Pike (Chapman, Wild Norway, p. 348, 1897); 9 April 1900, from notes of Dr. Bunge (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 308, 1902); and 29 April 1912 at Ice Fjord according to Dr. Rempp (Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 13, 1913).

In Nova Zembla (Sect. VIII): Kriwoscheja (Nature and Hunting, no. 11, p. 39, 1884) noted its arrival around 10 May 1883.

In the Franz Josef archipelago (Sect. IX) Neale (*fide* Clarke, Ibis, 1898, p. 267) identified the first birds, 6 May 1882; in 1895 Dr. Koettlitz noted the day of their arrival as 7 June, while Jackson (A Thousand Days in the Arctic, vol. 2, p. 406, 1897) had already observed them on 11 April of the same year. In 1896 he saw the first individuals 20 April and Dr. Koettlitz at Cape Flora first saw them 26 April. Finally, in 1897, the first ones appeared, according to the notes of Bruce, 14 April and became common there

the next day. Nansen (Collett and Nansen, Norw. North Polar Exp., pp. 25, 26, 1899) in 1895 observed the first Kittiwakes under latitude 82° 20′ on 13 June and at his winter-quarters, 13 May 1896; about 3 June 1896 flocks appeared near McClintock promontory. The "Fram" met with a bird of this species, 10 June 1895, north of the Franz Josef archipelago (*ibid.*, p. 47, 1899).

On the north coast of the Chuckche peninsula (Sect. XXI) Kittiwakes were found by the "Vega" Expedition 15 June 1879, but obviously this date cannot be regarded as the date of their first appearance in these areas.

The length of the incubation period has been determined for the Kittiwake by Faber as twenty-one to twenty-four days, while the chicks hatched out by Evans (Ibis, 1891, p. 81) in an incubator broke from the egg during the twenty-sixth day. I will adopt the period of twenty-four days as the average. The table following is based on the data at my disposal.

Breeding of the Kittiwake.

Incubation period, 24 days (approx.)	Spitzbergen (Sect. I)	Bear Island (Sect. II)	Murman Coast (Sect. III)	Nova Zembla (Sect. VIII)	Franz Josef Archipelago (Sect. IX)
Set completed	13 Je 1900[1] *2 Jy 1900*[1] (eggs much incubated—20 days) 21 Je 1900[1] 1 Jy 1910[2]	20 May 1898[3] 21 May 1907[4] 30 May 1907[4] *17 Je 1907* (much inc., 18 days) 10 Je 1899[5] *13 Je 1898*[3] *17 Je 1907*[4] one egg 19 Je 1907[4]	*19 May*[6] *13 Je*[6]	4 Jy 1904[7]	13 Je 1897[8] *1 Jy 1897*[8] (much inc., ? 18 days) *20 Je 1896*[9]
Date of hatching	7 Jy 1900[1] *15 Jy 1900*[1] *25 Jy 1910*[1]	*13 Je 1898*[3] 14 Je 1907[4] *17 Je 1907*[4] (young several (3?) days old) 23 Je 1907[4] *4 Jy 1898*[3] 7 Jy 1898[3] 13 Jy 1907[4]	13 Je[6] 7 Jy[6]	*28 Jy 1904*[7]	7 Jy 1897[8] 14 Jy 1896[9]

[1] Obs. of Dr. Bunge; Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 317, 1902.
[2] Zedlitz, Journ. f. Ornith., vol. 59, p. 311, 1911.
[3] Römer and Schaudinn, Ornith. Monatsb., vol. 8, p. 119, 1900.
[4] König, Avif. Spitzb., p. 187, 1911.
[5] Swenander, Bih. Kongl. Svenska Vet.-Akad. Handl., vol. 26, pt. 4, no. 3, p. 18, 1900.
[6] Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130, 1902 (in Russian).
[7] Bilkiewicz, App. Scient. Res. Exped. Univ. Kasan, p. 17, 1904 (in Russian).
[8] Clarke, Ibis, ser. 11, vol. 4, p. 268, 1898.
[9] Collett and Nansen, Norw. North Polar Exp., p. 26, 1899.

It is quite clear that the Kittiwakes lay their eggs at somewhat different times, or more probably that if a considerable number are destroyed these must be replaced and are hatched later in comparison with those laid normally. It was noted by most of the observers that fresh eggs were found at the same time as more or less incubated eggs and chicks some days old; or even young birds already able to fly were found together with those just hatched. Thus in Spitzbergen (Sect. I) Römer and Schaudinn (1900) on 16 August found young not yet able to fly, although the first young birds had already begun to fly by 27 July. On Bear Island (Sect. II) they record eggs at the beginning of the incubation on 13 June while at the same date they found some downy young. Swenander (1900) found on 22 July one brood and two others in the down, while Professor König (1911) on 17 June 1907 found some nests that contained but a single egg (set still incomplete), others that held heavily incubated eggs and at the same time young birds several days old.

I must again call the reader's attention to the fact that the time of laying the eggs and that of the hatching of the young vary in different years according to the more or less favorable time of the year in question. We see for example that on the Murman coast (Sect. III) Goebel (1902) found fresh sets in some years on 19 May but in others on 13 June.

The time when the young birds begin to fly is as follows: Römer and Schaudinn (1900) noted this at Spitzbergen (Sect. I) 22 July; Count Zedlitz (1911) on 9 August; Dr. Walter (Journ. f. Ornith., vol. 38, p. 240, 1890) on 29 July, and Münsterhjelm (Oefv. Finsk. Vet.-Soc. Forh., vol. 52, p. 20, 1910) on 15 July 1910. On Bear Island, according to Count Zedlitz (1911), most of the young birds were already on the wing by 12 August, and Swenander (1900) fixes this time at the beginning of August.

Notes as to the time of the Kittiwake's departure from the arctic lands are much fewer than those as to its arrival. At Spitzbergen (Sect. I) Pike (Chapman, Wild Norway, p. 394, 1897) saw the last birds on Amsterdam Island on 13 October, and Dr. Bunge (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 307, 1902) observed a few 4 October 1899. Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 87) records that the last were seen in Matochkin-shar, Nova Zembla (Sect. VIII) on 25 October 1902. For the Franz Josef archipelago (Sect. IX) we have the following data as to its departure: about 22 September 1881, according to Neale (Clarke, Ibis, 1898, p. 267); the end of September 1894 (Jackson, A Thousand Days in the Arctic, vol. 2, p. 406, 1899); 7 October 1895 according to Dr. Koettlitz (Clarke, 1898); 30 September 1895 and 25 September 1896 (Jackson, 1899) and 5 October 1896, *fide* Bruce (Clarke, 1898). During the "Fram" Expedition the Kittiwake was present in 1894 up to the middle of August under latitude 81° north, longitude 128° east (Collett and Nansen, Norw. North Polar Exp., p. 15, 1899).

In 1895 they remained in the vicinity of Nansen's winter-quarters up till mid-September. Toward the north pole, the Kittiwake was found by the members of the "Fram" Expedition as far as north latitude 84° 52′ (Collett and Nansen, Norw. North Polar Exp., p. 47, 1899).

23. **Xema sabini** (J. Sabine).

Xema sabinei. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 8, 45, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult (female) and three young, 15 August 1901, Camp Michailow, Kotelny Id. (O. Cionglinski).

Local names: in Samoyede (Taimyr), *sónna-tattächku* (Middendorff); in Yakut, *tyrticha* (Dr. Bunge).

Although Sabine's Gull is without doubt a circumpolar bird, it inhabits the Eurasian portions of the Arctic Ocean in limited numbers and only nests in more considerable abundance in particular parts of these regions. On Spitzbergen (Sect. I) according to König (1911) a few specimens have been taken, but he himself is the only one who has succeeded in finding a set of eggs of this bird and in taking the parent birds, thus establishing the nesting of the species in Spitzbergen. Later a single individual of this Gull was also observed in King's Bay by Mathey-Dupraz (Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 114, 1913). Jourdain (Ibis, 1922, p. 173) states that Huxley met with a small Gull, perhaps a young bird of this species, on 7 July 1921, near Richard Lagoon, Prince Charles Foreland. Finally according to Langstaff (Ibis, 1924, p. 488) Dr. A. Hoel of Christiania succeeded in obtaining a pair in 1922 at Deer Bay; on 26 August the members of the Merton College Expedition shot at the same place, a young bird which escaped in the sea, but on account of the rarity of the species they refrained from killing the parent birds. In the latitudes of the Murman coast (Sect. III), this Gull, according to the observations of Smirnow (Ornith. Jahrb., vol. 12, p. 205, 1901) appears in limited numbers during the winter in the eastern parts of this coast, where it was seen in 1901 near Morshowetz Island, ten miles from Swjatoi Noss at sea, opposite the Eastern Litza, between Litza and Chorlovka, and opposite Chorlovka between 30 April and 6 May. Fedossow (The Hunter and Fisherman of Ukraine, 1926, no. 7, p. 28–29) has had the good fortune to find egg-shells on Lake Promoinoje, Kolguev Island (Sect. V) and to capture two young birds of a small, black-headed Gull which he identified as *Larus minutus* Pallas; by correspondence with this author and by notes from his diary I have been able to persuade myself that the species in question is Sabine's Gull. In July 1896 the "Fram" Expedition recorded under 83° north latitude, to the north of Spitzbergen, a black-headed Gull which according to Collett and Nansen (1899) was undoubtedly a Sabine's Gull.

In Eastern Taimyr (Sect. XIII) the late Academician Middendorff was the first (Sibir. Reise, vol. 2, pt. 2, p. 244, 1853) to find this species of Gull nesting along the Taimyr River; next, the pilot Lund of the "Lena" (auxiliary vessel of the "Vega" Expedition) succeeded in taking a specimen on 22 August 1878 under 76° 47′ north latitude and 115° 54′ east longitude, to the northeast of the east coast of the Taimyr peninsula (Palmén, 1887); finally Birula of the Russian Polar Expedition observed on 2 September 1901, some Gulls that he identified as *Xema sabini* (Sabine) in sight of one of the islands of Eastern Taimyr, probably St. Paul Island. At the mouth of the Lena (Sagastyr) (Sect. XIV) Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, pp. 123, 124, 127–129, 1887) found this species. O. Cionglinski, a member of one of the auxiliary parties of the Russian Polar Expedition, killed an adult bird (probably a female) and three young ones, 15 August 1901, at Camp Michailow, Kotelny Island (Sect. XVI). At the mouth of the Kolyma (Sect. XIX) this Gull has been recorded as a migrant. Professor Palmén's (1887) citations of this species on Wrangel and Herald Islands are probably based on Nelson's records (Cruise of the Corwin, p. 109, 1883) but later Nelson himself admits that the Gulls seen there were more probably Rosy Gulls. Snyder (Univ. Toronto Studies, biol. ser., no. 28, p. 11, 1926) informs us that meanwhile the Crawford Expedition of 1922 to Wrangel Island succeeded in obtaining there three adult specimens of Sabine's Gull. Finally, for the north coast of the Chukchi peninsula (Sect. XXI) we have only the single observation of a black-headed Gull made 3 November 1878 by the members of the "Vega" Expedition at its winter-quarters (Palmén, 1887). Its arrival in Taimyr was noted by Middendorff (1853), 5 June 1843; by 10 July 1843 heavily incubated eggs were found, and by 17 July some young birds were already well grown.

24. **Pagophila eburnea** (Phipps).

Pagophila eburnea (Phipps). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 388, 1901; *ibid.*, vol. 16, no. 5, p. 238, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 160, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 3, 8, 17, 18, **58**, 1907.
Weisse Möwe. Toll, Die russ. Polarf. d. "Sarja," p. 572, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: male, semi-adult, 2 September 1902, Island of New Siberia (A. Birula); male semi-adult, 12 September 1902, same locality and collector.

Local names: in Chukchi, north coast of Chukchi peninsula, *chynon-jajak* (Palmén, 1887).

The Ivory Gull is recorded from almost every part of the region of the Eurasian tundra, though we are quite without data for the mouths of the Pechora (Sect. VI), the Yana (Sect. XV), the Indigirka (Sect. XVIII) and the Kolyma (Sect. XIX), as well as for Wrangel Island (Sect. XX). But it is only in certain ones of my "Sections" that it

nests, while in all the others it appears solely outside of the breeding season, sometimes wintering along the coasts of the Arctic Ocean, sometimes occurring during its wanderings in autumn or spring. In Spitzbergen (Sect. I) the Ivory Gull nests in considerable numbers but chiefly in the northern and eastern parts of the archipelago. In Professor König's work (1911) will be found a complete enumeration of the nesting places in Spitzbergen. The second breeding place of this Gull is the Franz Josef archipelago (Sect. IX) (observation of Bruce, see Clarke, Ibis, 1898, p. 264). Again it has been recorded as breeding on both islands of Nova Zembla (Sect. VIII) and perhaps on Lonely Island (Sect. XII) (Mohn, Peterm. Geogr. Mitth., 1879, p. 57–59) and lastly Nelson (Cruise of the Corwin, p. 104, 1883) supposes it nests on Bennett Island (Sect. XVII). On Bear Island (Sect. II) it is recorded as a bird of passage, migrating probably from its wintering places along the Murman coast to its breeding grounds in Spitzbergen. In all the other parts of the region of the Eurasian tundra, it appears in limited numbers only in the course of its nomadic life during the non-breeding season.

The Russian Polar Expedition was unable to discover anywhere a breeding place of the Ivory Gull and only observed single birds from time to time. The first appeared, according to Dr. Walter (1901), in Dickson Bay (Sect. XI); next, on 22 September 1900, three individuals in Kolomeitzeff Bay, and 9 October 1900 a single individual at the winter-quarters of the "Sarja" (Sect. XII) (Birula, 1907). In the summer of the year 1901 the Ivory Gull was seen but once in the month of July (Walter, 1902). During the passage of the "Sarja" from Western Taimyr to Bennett Island in 1901, several individuals of this Gull appeared 2 September, in the latitudes of Eastern Taimyr (Sect. XIII) near one of the islands, probably St. Paul Island. Again, Birula (1907) met with it on the west coast of the Island of New Siberia, first on 31 August 1902, and succeeded in procuring two specimens, 10 and 11 September 1902. Finally, according to Baron Toll (1909) and Dr. Katin-Jartzeff (*in litt.*), Quartermaster Tolstow saw three 20–21 May 1902 in the vicinity of Camp Wolosowicz on Kotelny Island.

We have at hand the following data as to the time of arrival of the Ivory Gull in the different parts of the Eurasian tundra region. In Spitzbergen (Sect. I) it appears in mid-March, 18 March 1900 at Horn Sound, according to Dr. Bunge (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 308, 1902) and 15 March 1889, at Amsterdam Island, according to Pike (Chapman, Wild Norway, p. 348, 1897); in the Franz Josef archipelago its appearance was noted by Jackson (A Thousand Days in the Arctic, pp. 393, 404, 1899) on 5 March 1895, and by Dr. Koettlitz (Clarke, Ibis, 1898, p. 264) at Cape Flora 16 April 1895; by Jackson (1899) on 20 March 1896, by Bruce (Clarke, 1898) 10 April 1897, and by Neale (Clarke, 1898) 20 April 1882. Nansen (Collett and Nansen, Norw. North Polar Exp., p. 31, 1899) observed the first pair of these birds in latitude

82° 20′ north on 31 May 1895 and at his winter-quarters on 12 March 1896 (1899, p. 32); finally the "Fram" (1899, p. 49) recorded their probable appearance under 84° 38′ north latitude on 14 May 1895 and in north latitude 83° 50′ (north of Spitzbergen), 13 May 1896.

Data as to the breeding of this bird are insufficient to allow of defining exactly the different stages of this periodic phenomenon. It is clear that no naturalists have been able to reach the breeding grounds of the Ivory Gull until the season was far advanced, and they have found for the most part well-incubated eggs or young already hatched. Malmgren (Journ. f. Ornith., vol. 11, p. 375, 1863) recorded young already clothed with down, 30 July, in eggs found in Murchison Bay, Spitzbergen (Sect. I). The nineteen eggs found by Professor Collett (Ibis, 1888, p. 442) in Ice Fjord, 8 August, contained completely developed young, while at the same time there were many nestlings of different ages and even young birds already able to fly. The same thing was also observed by Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 118, 1900). These naturalists found on 2 August many slightly incubated eggs while at the same time in the greater part of the nests there were downy young, in part fairly well grown and even a considerable number of those that could already fly. In the Franz Josef archipelago (Sect. IX) Bruce found three young, 7 August 1897, one of which was but a few days old, while the two others, though older, still carried their down plumage (Clarke, Ibis, 1898, p. 264).

As to the time of departure of this species we have only a few dates from the region of Nova Zembla and the Franz Josef archipelago. Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 88) saw the last birds of this species at Matochkin-shar, Nova Zembla, 25 October 1902. In 1895, Jackson (1899) saw the last ones 14 October and Dr. Koettlitz (Clarke, 1898) at Cape Flora the last adult birds 18 and the last young ones 30 September; in 1896 the last individuals were noted at Cape Flora by Bruce (Clarke, 1898) 3 October and by Jackson, 7 October. According to Neale's observations (Clarke, 1898) they remained in 1881 up to the end of October. Nansen (Collett and Nansen, p. 32 1899,) states that the immature birds remained in 1895 in the vicinity of his winter-quarters until the beginning of October. The crew of the "Fram," during the period when their vessel was beset, noted the presence of the Ivory Gull as far north as latitude 84° 38′ (Collett and Nansen, 1899, p. 49).

25. **Rhodostethia rosea** (Macgillivray).

Rhodostethia rosea (Macgillivray). Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 16, p. 203, 1902; *ibid.*, vol. 20, no. 5, p. 158–160, 1904. Matiessen, *ibid.*, vol. 18, no. 3, pp. 72, 78, 1903. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 8, 16–18, 55, 1907. Toll, Die russ. Polarf. d. "Sarja," p. 397, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: immature, 6 August 1902, Rosowaty promontory, Nerpalach, Kotelny Id. (Dr. V. Katin-Jartzeff); immature, 10 August 1902, Schileiko promontory, Kotelny Id. (Dr. V. Katin-Jartzeff); immature, 30 August 1903, south coast of Island of New Siberia (Dr. V. Katin-Jartzeff); immature, 30 July 1903, Medweshi promontory, Kotelny Id. (Lieut. A. Kolchak); immature, 31 July 1903, Medweshi promontory, Yelesseyeff Camp, Kotelny Id. (Lieut. A. Kolchak); immature, 3 August 1903, southeastern Bunge Land, Kotelny Id. (Lieut. A. Kolchak).

In alcohol: immature, 16 August 1902, Island of New Siberia (A. Birula).

Local name: in Chuckche, *erikadlin* (Palmén).

During his journey to the Kolyma in 1905, Buturlin (Ibis, 1906, pp. 131–139, 333–337, 661–666; Bull. Soc. Zool. Genève, vol. 1, pp. 375–392, 1912) was most successful in solving the problem as to the breeding ground of the Rosy Gull. According to his account this Gull nests in low marshy places, covered with herbage, in the subalpine and even the forested zones of the lower courses of the Alazeya, Indigirka and Kolyma Rivers, occasionally even at a distance of almost 150 kilometers south of the tree line. I am in a position to add to these notes, that Birula (1907) learned from the natives that a small Gull nested at the mouths of the rivers emptying into the Arctic Ocean between the Indigirka and the Swjatoi Noss promontory; furthermore the natives on their visits to the "Sarja," when shown specimens of Rosy Gulls affirmed that these birds nested in the vicinity of Swjatoi Noss promontory. Outside the above-mentioned breeding grounds of the Rosy Gull, we have only the following data as to its appearance in the latitudes of the Eurasian Arctic Ocean. For Spitzbergen (Sect. I) there is only an old record of the Parry-Ross Expedition, of the finding of this Gull in Hinlopen Strait. This observation is doubted by Malmgren and Professor König (1911) and the latter has thought it best to eliminate the species from the list of Spitzbergen birds. However, taking into consideration the great numbers of these Gulls seen by Nansen (Collett and Nansen, Norw. North Polar Exp., p. 27, 1899) to the northeast of the Franz Josef archipelago, the casual occurrence of single individuals in the Spitzbergen region is quite admissible. On the other hand it is highly probable that this observation may refer to *Xema sabini* (Sabine) which nests, though in limited numbers, in Spitzbergen. I therefore feel obliged to reinstate this species in the list of Spitzbergen birds, though with a question-mark, in view of the doubts of some of my colleagues. For the Franz Josef archipelago (Sect. IX), properly speaking, we have but the single observation of Jackson (A Thousand Days in the Arctic, p. 403, 1899) of a solitary individual observed 5 July 1897. But during the voyage of the "Fram" (Collett and Nansen, 1899, p. 48) the Rosy Gull was noted by the ship's company between 18–19 July and 11 August 1895 at latitude 84° 27′ to 84° 41′ north and by Nansen in the latitudes of Hvidtenland in such large numbers that he

has even expressed his belief that the species must nest somewhere in that vicinity, perhaps on Liv Island. Between the Franz Josef archipelago and Nova Zembla a specimen was killed by J. Payer (Ibis, 1878, p. 200) of the Austrian Polar Expedition. At the mouth of the Lena (Sect. XIV) Dr. Bunge secured a pair of these birds in the vicinity of their station at Sagastyr. Full particulars as to the conditions under which the Rosy Gull appears along the shores of the New Siberian archipelago will be set forth in the enumeration of the records of this species made by the Russian Polar Expedition. During the drift of the "Fram" (see Collett and Nansen, 1899) between 15 and 20 August 1894, eight Rosy Gulls were seen in latitude 81° 5′ to 81° 8′ north, and longitude 127° 30′ east, at about 560 kilometers from the New Siberian archipelago and Cape Cheljuskin. In the region of Bennett Island (Sect. XVII) a considerable series of Rosy Gulls was secured by the "Jeanette" Expedition (De Long, The Voyage of the Jeanette, pp. 385, 387, 390, 616, 1883) and the Russian Polar Expedition also found the species first while approaching the island on the "Sarja" in the autumn of 1901, and again during the late Baron Toll's expedition in 1902 (Dr. Walter, *in litt.;* Birula, 1907; Toll, 1904, 1909).

Newcomb, the naturalist of the "Jeanette" Expedition, has recorded and collected this species in the Arctic Ocean adjacent to Wrangel and Herald Islands (Sect. XX) (De Long, 1883, p. 151). Finally a young bird was killed by Dr. Almquist of the "Vega" on the northern coast of the Chukchi peninsula (Sect. XXI), at Pitlekaj, 1 July 1879 (Palmén, 1887) and Koren saw four young birds north of Ajan Island (northern part of Chaun Bay, Sect. XXI), 20 August 1914 (Riley, Proc. U. S. Nat. Mus., vol. 54, p. 612, 1918). But probably, as was the case in 1882, enormous numbers of Rosy Gulls pass along the north coast of the Chukchi peninsula from their breeding places, situated westward, to Alaska (Murdoch, Rept. Polar Exp. Pt. Barrow, p. 123, 1885).

The Russian Polar Expedition first met with the Rosy Gull, as above mentioned, between 10 and 13 September 1901 in sight of Bennett Island (Sect. XVII). At the edge of the ice adult and young birds were present in such numbers that Dr. Walter (*in litt.*) and Birula (1907) felt certain they were breeding there. However, in the summer of 1902 the Rosy Gull was not seen in the vicinity of the "Sarja's" second winter-quarters, in Nerpalach Bay, Kotelny Island (Sect. XVI); but on 6 August the first immature birds put in an appearance and were killed on Rosowaty promontory (Dr. Katin-Jartzeff, *in litt.*). In 1903 during the expedition in search of Baron Toll, Naval Lieutenant A. Kolchak (*in litt.*) secured specimens of this Gull, 30 and 31 July and 3 August on Medweshi promontory and in southwest Bunge Land, Kotelny Island, the first of which was found dead. Birula (1907) noted single individuals and small flocks between 14 and 18 September 1901, during the passage of the "Sarja" from Bennett Island toward Nerpalach Bay. During his stay on the Island of New Siberia (Sect. XVI) in 1902 the first

Rosy Gull appeared 16 August; the birds became numerous after 5 September and particularly during two weeks after 11 September. Many flocks of adult and young birds stayed offshore in sight of this island, but the adults especially were rather shy so that Birula was able to secure only one immature bird. A second specimen was taken on the south coast of the same island 30 August 1903 and preserved by Dr. Katin-Jartzeff.

In the natural history of the Rosy Gull, two very curious and interesting points need explanation in a more precise fashion, namely, the question whence come the birds that appear in autumn on the coasts of the islands of the New Siberian archipelago and at Bennett Island; and the question of the absence or the presence of a breeding place in the region of the Franz Josef archipelago. The opinions expressed by Buturlin (Bull. Soc. Zool. Genève, vol. 1, p. 375–392, 1912) on these two subjects, and more especially on the first, are very convincing but lack absolute proof. I have personally discussed this matter with Buturlin, and he has wholly sustained his deductions as set forth in his last article on the nesting places of the Rosy Gull (1912). According to his observations, the young birds of this species left their nesting grounds in the vicinity of Pochodskoje, Kolyma River system, between 26 and 31 July, while still with down on the head, and made their way on foot to the shores of the Arctic Ocean and they then left the Siberian coasts as soon as they could fly. Without expressing any doubt as to the possibility of this very singular and unusual occurrence, I still feel obliged to ask this question: Why do not the young Rosy Gulls, which probably seek the shores of the Arctic Ocean because its pelagic life offers them a varied and abundant source of food, remain in the region of the north coasts of Siberia but go instead to the edge of the ice on the coasts of the New Siberian and Bennett Islands? The only sufficient explanation consists in the fact that the streams and rivers which empty into the Arctic Ocean of Siberia bring down such a quantity of fresh water, especially about their mouths, that the pelagic fauna of these regions is much less rich and varied than it is on the coasts of those islands. The appearance of the first Rosy Gulls on the coasts of Kotelny Island was noted in 1902 by Dr. Katin-Jartzeff 6 and 8 August and in 1903 by A. Kolchak 30 and 31 July. The young birds therefore require nearly a week or ten days for the passage from the Siberian mainland to the New Siberian archipelago. The fact that they do not delay undertaking this journey as soon as they have reached the shores of the Arctic Ocean is proved by the finding of a dead specimen, 30 July 1903, near Medweshi promontory, Kotelny Island, with remains of the downy plumage on the head.

The second question, as to the source of the rather large numbers of adult Rosy Gulls which Nansen observed north of Hvidtenland (northeastern part of the Franz Josef archipelago) is still more difficult to solve. Nansen has recorded his belief that a breeding place of this species exists in the region of the Franz Josef archipelago, for example on

Liv Island (Collett and Nansen, 1899, p. 27). Buturlin (1912), however, controverts this idea as follows:—

> It cannot be that the Rosy Gull breeds in Franz Josef Land where the Duke of the Abruzzi's Expedition, during one summer, and the Jackson-Harmsworth Expedition during three summers in the south part, were unsuccessful in finding this bird, while Nansen in 1895 did not meet with the first individual until 27 July. . . . The sandy and pebbly shores, the rocky slopes and the elevated and stony tundras of the arctic islands of Franz Josef and Nova Zembla and of Bennett and Wrangel Islands are apparently unsuitable as nesting places for the Rosy Gull. During June and July it is a dweller in low marshes covered with herbage in the tundra or the *taiga* (forest zone).

These arguments, it seems to me, are quite pertinent and I cannot admit longer that the Rosy Gull (which regularly nests after the manner of *Larus minutus, Larus ridibundus, Larus canus* and probably also of *Xema sabini*), changes its method of life and becomes an inhabitant of gull-rocks like the Kittiwake (*Rissa rissa=tridactyla*) or Ivory Gull (*Pagophila eburnea*), or a dweller on sandy or pebbly shores like the Terns (*Sterna*). But on the other hand, while admitting the possibility of their traveling in the course of from seven to ten days from their nesting places at the mouths of streams and rivers of northern Siberia to the shores of the islands of the New Siberian archipelago and of Bennett and Wrangel Island, their journey from the same nesting places on the Kolyma to the northeast of the Franz Josef archipelago (Hvidtenland) at the dates indicated by Nansen is quite out of the question. Nevertheless Nansen has shown the presence of adult birds in those regions after 11 July 1895, and of the first young birds 27 July, that is, at the same time that Buturlin stated for their departure from the breeding grounds on the Kolyma. Between 3 and 8 August 1894, eight individuals were seen about ten days later than usual by the crew of the "Fram" in 81° 5′ to 81° 8′ north latitude and 127° 30′ east longitude in the region intermediate between the hatching ground on the Siberian north coast, and Franz Josef archipelago, and at a distance of 560 kilometers from the New Siberian archipelago and Cape Chcljuskin (Collett and Nansen, 1899, p. 15). But in contradiction of their supposed occurrence at the high latitudes exclusively after the breeding period, the crew of the ill-fated "Jeanette" (De Long, The Voyage of the "Jeanette," vol. 2, pp. 385, 387, 390, 616, 1883) reported the presence of this species during the drift of their vessel on 22, 23 and 25 June 1880 and 30 June 1881 (that is, during the breeding season) to the northeast of Bennett Island. It is quite clear that the adult Rosy Gulls and especially the young birds, in coming from the north coast of Siberia, could not reach Hvidtenland on the dates given by Nansen, any more than those birds observed at the end of June by the crew of the "Jeanette" northeast of Bennett Island could have reached that locality from their breeding grounds on the Kolyma. One could therefore admit but two possibilities: (1) that these were cases of birds that had lost their eggs by inundation or other reasons and had in consequence

deserted their breeding grounds, or (2) that with the Rosy Gull, as with other species of Gulls, the immature birds of from one to three years of age take no part in reproduction and inhabit the regions mentioned because of the abundance there of pelagic animals which form their principal food.

The very interesting question as to the origin of the Rosy Gulls to the northeast of the Franz Josef archipelago must be regarded as still not definitely solved and must be left for study by future polar expeditions.

Obviously Buturlin is the only one who has had an opportunity to study the breeding habits of the Rosy Gull and to determine certain dates of the periodic events in its life history. This author recorded the appearance of the first bird at the mouth of the Kolyma 12 June 1905; the following day he was able to note the presence of several dozen of these birds, in pairs. On 26 June, several sets of eggs were brought to him, slightly incubated; on 9 July eggs contained young in down that would have hatched in a few days; on 13 July this explorer took a young bird a few days old and on 19–20 July seven chicks of different sizes. Between 26–31 July the young left the place where they were hatched and on 4 August Buturlin killed at Soucharnaja some young birds that were already able to fly.

It only remains for me to add that the most northerly point where the Rosy Gull has been observed, was established by the crew of the "Fram" in 84° 41′ north latitude (Collett and Nansen, 1899, p. 48).

Sterna hirundo Linné.—The Common Tern has been recorded only by Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903 (in Russian)) as nesting on Pasvig-elf in Russian Lapland (Sect. III). In my work on the avifauna of that country (Pleske, Beitr. Kenntn. Russ. Reichs, ser. 2, vol. 9, p. 383, 1886) I have already expressed the opinion that this species of *Sterna* does not belong to the fauna of Russian Lapland—and most of the records are based on inaccurate determinations that really refer to the Arctic Tern. Even if Goebel's identification of *Sterna hirundo* is correct, it must obviously relate to a case of accidental nesting of this species in Russian Lapland, though it is much more likely that these observations should be referred to the Arctic Tern, *Sterna macrura* Naumann. Goebel, as an amateur ornithologist, did not take care in any case to preserve some specimens of the bird that would make possible the verification of his identifications. Moreover, as an oölogist, he was very little interested in birds and often confused different species. In any case, Goebel's records as to the nesting of the Common Tern in Russian Lapland should be considered as very improbable and treated with the greatest reserve. The accidental occurrence of this species in the latitudes of Russian Lapland is established by the specimen brought back by the Scientific Expedition to the Murman coast (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 268, 1902).

26. Sterna macrura Naumann (=paradisaea Brünnich).

Sterna macrura Naumann. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 232; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 159, 1902. Brusneff, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 181, 1904. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 5, 7, 12, 16, 59, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult male, 7 July 1902, adult male, 16 July 1902, young, 23 July 1902, all from Kotelny Island (Dr. V. Katin-Jartzeff); adult, 6 July 1901, adult, 17 July 1901, adult, 5 July 1901, adult, 14 July 1901, adult, 24 July 1901, adult, 26 July 1901, adult, 20 July 1901, adult, 4 August 1901, all from Camp Michailow, Kotelny Island (O. Cionglinski); adult, 6 July 1903, Camp Yelesseyeff, Kotelny Island (P. Olenin); adult, 26 August 1903, Camp Birula, Island of New Siberia (M. Brusneff).

In alcohol: adult, 9 August 1902, Island of New Siberia (A. Birula).

Eggs: one, 16 July 1902, Kotelny Island (Dr. V. Katin-Jartzeff); two and one, 7 July 1902, Camp Yelesseyeff, Kotelny Island (P. Olenin); three, Camp Yelesseyeff, Kotelny Island (Wollosowiez?); one, 26 June 1903, Faddejefski Island (S. Tolstow).

Local names: In Russian, in the Yana region, *tschernogrudka* (Birula); in Yakut, *tyrächa* (Bunge, Birula); in Tunguse, *kylerka* (Birula); in Chuckehe, *tekechyak* (Palmén).

The Arctic Tern as a circumpolar species inhabits almost every region of the Eurasian tundra. Hitherto it has not been observed in the De Long group of islands (Sect. XVII) nor on Wrangel and Herald Islands (Sect. XX), but has been recorded from all the other parts of the area, though inhabiting the different sections in unequal abundance, at times in great colonies, again to the number of a few pairs only.

The Russian Polar Expedition found this Tern in all the places visited during its voyage. The first individual was seen by Birula (1907) in the Kara Sea, 12 August 1900, and then by the late Dr. Walter (*in litt.*) on 23 August 1900 in a bay to the eastward of Dickson Bay. In Western Taimyr, in the vicinity of the "Sarja's" first winter-quarters, the Arctic Tern was present in very limited numbers, nesting in scattered pairs, as, for example, in Walter Bay (Walter, 1901, 1902; Birula, 1907). Among the islands of the New Siberian archipelago this species was more plentiful. For Kotelny Island we have the material gathered by Naval Lieutenant A. Kolchak (*in litt.*) and Dr. Katin-Jartzeff (*in litt.*) and a series of specimens of birds and eggs collected chiefly in 1901, by the auxiliary expedition of O. Cionglinski, in part in 1902 by Dr. Katin-Jartzeff and in 1903 by Olenin. During his stay in 1902 at the Island of New Siberia, Birula (1907) found the Arctic Tern in much greater abundance than in Western Taimyr and especially at the mouths of the rivers, opposite which the ocean supported an abundant pelagic fauna. In 1903 the auxiliary expedition of Brusneff (*in litt.*, 1904, *et coll.*) made the same observation on this island. Finally Quartermaster Tolstow found the species in 1903 on Faddejefski Island.

The dates of arrival of the Arctic Tern in the latitudes of the Eurasian Arctic Ocean may be grouped in the following table.

From this table, the Arctic Tern is seen to make its appearance at Spitzbergen (Sect. I) regularly about 1 June, and in years with a late spring, about 23 June; on the Murman coast (Sect. III) it arrives usually about 21 May, and in slightly late seasons, about 26–28 May; in the Franz Josef archipelago between 17 and 21 June, or a

Migration of Arctic Tern.

Spitzbergen (Sect. I)	Murman Coast (Sect. III)	Franz Josef Archipelago (Sect. IX)	Western Taimyr (Sect. XII)	New Siberian Archipelago (Sect. XVI)
	Yeretiki:			Id. of New Siberia:
3 June 1887[1]	26 May 1883[5]	17 June 1895[6]	26 June 1901[8]	15 June 1902[9]
3 June 1889[2]	21 May 1884[5]	20 June 1895[7]		Faddejefski Id.:
31 May 1900[3]	21 May 1899[5]	18 June 1896[6]		8 June 1903[10]
24 June 1912[4]	28 May 1900[5]	21 June 1896[7]		
	Alexandrovsk:			
	22 May 1901[5]			
	Kola: 17 May 1901[5]			

[1] Pike in Chapman, Wild Norway, p. 350, 1897.
[2] Walter, Journ. f. Ornith., vol. 38, p. 238, 1890.
[3] *Fide* Bunge, Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 308, 1902.
[4] *Fide* Dr. Rempp, Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 115, 1913.
[5] Goebel, Ornith. Jahrb., vol. 12, p. 215, 1901.
[6] Clarke, Ibis, ser. 11, vol. 4, p. 276, 1898.
[7] Jackson, A Thousand Days in the Arctic, p. 402, 1899.
[8] Dr. Walter, *in litt. et* 1901, 1902; Birula, 1907, p. 5.
[9] Birula, 1907, p. 59.
[10] Brusneff, 1904.

month later. In Western Taimyr the members of the Russian Polar Expedition noted its arrival 26 June 1901 and in the New Siberian archipelago between 8 and 15 June.

The length of the incubation period has been fixed by Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 105, 1900) at approximately eighteen days, probably based on the observations of Faber in Iceland. Experiments by Evans (Ibis, 1891, p. 81) with the aid of an incubator prolonged this period for *Sterna hirundo* Linné to twenty-one or twenty-three days with an average of twenty-two days, and Naumann (Naturg. Vög. Deutschl., vol. 10, p. 140, 1840) mentions for *Sterna macrura* a duration up to fifteen or sixteen days. I must give preference to the exact data secured with the use of the incubator and will make my calculations on the basis of an incubation period of twenty-two days. The period between the hatching of the young and the time when they begin to fly is still more difficult to determine; however, the observations of Count Zedlitz (Journ. f. Ornith., vol. 59, p. 314, 1911) at Spitzbergen that the young were hatched 22 July and began to fly on 8 August, fix the length of this period at seventeen days and I shall make no mistake if I take twenty days as an average. It is clear that in common with a considerable number of other species of birds, the times when the Arctic Tern lays its eggs vary in accordance with the more or less favorable season of any particular year. Moreover, it has also been shown for this species that one finds quite fresh eggs very late in the summer, side by side with heavily incubated eggs, newly hatched young and chicks already well advanced in development. Evidently the Terns also lose a number of eggs

either on account of an unfavorable season, or because they are robbed by predaceous enemies; and this loss they make good by laying new sets.

The following table summarizes the data coming from different sections of the Eurasian tundra region and the deductions drawn from the actual observations (printed in italics).

From this table we may draw the following conclusions. In Spitzbergen (Sect. I) the normal sets are complete between 30 June and 9 July; sometimes they are earlier, sometimes later by seven or eight days. At Bear Island (Sect. II), as shown especially by Professor König (1911), egg-laying takes place almost two weeks later than at Spitzbergen. On the Murman coast (Sect. III) the sets are complete about 2 to 12 June. Dates for Nova Zembla (Sect. VIII) and for the mouth of the Lena (Sect. XIV) correspond perfectly and place the laying of the eggs at 26 and 27 June. The young hatch usually three weeks later (twenty-two days) and the young birds begin to fly after another interval of about three weeks (twenty days). But I must repeat that these statements refer only to normal sets and that even in August one may find perfectly fresh eggs and at the same time young birds already beginning to fly.

Notes as to the breeding of the Arctic Tern brought back by the Russian Polar Expedition are not many; there is only the observation of the late Dr. Walter (*in litt.*) that presents some interest, namely, that Arctic Terns had rather large young 9 August 1901 at the first winter-quarters of the "Sarja." In its manner of nesting in the arctic countries visited by the Russian Polar Expedition as well as in the coloration of its eggs, this species differs in no wise from what is usual elsewhere. The eggs brought back by the Russian Polar Expedition present the following dimensions and weights:

1. *7 July 1903, Camp Yelesseyeff, Kotelny Id.* (*P. Olenin*): 41 mm. x 30 (—); 42 x 30 (—).

2. *26 June 1903, Faddejefski Id.* (*S. Tolstow*): 40.2 mm. x 30 (110 eg.).

3. *16 July 1902, Nerpalach Bay, Kotelny Id.* (*Dr. V. Katin-Jartzeff*): 44 mm. x 30.2 (115 eg.).

As to the time of departure of the Arctic Tern from the polar regions, we have the following data: at Spitzbergen (Sect. I) the last birds were noted by Cocks (Zool., 1883, p. 484) on 9 September and by Münsterhjelm (Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910) 5 September 1910; in the Franz Josef archipelago (Sect. IX) at Cape Flora, according to Jackson (A Thousand Days in the Arctic, p. 402, 1899) and Clarke (Ibis, 1898, p. 262) five birds were seen on their migration, 17 September 1895. Finally at Golchiha, at the mouth of the Yenisei (Sect. XI) Miss Haviland (Ibis, 1915, p. 397) saw this species but once, on 18 August 1914. At the Island of New Siberia (Sect. XVI), Birula (1907) found the Arctic Tern in the middle of August but did not record the exact date of its last appearance. The species was noted by the crew of the "Fram" 21 June

Breeding of Arctic Tern.

Incubation period 22 days. Time of hatching till young begin to fly 20 days.	Spitzbergen (Sect. I)	Bear Island (Sect. II)	Kola Peninsula (Sect. III)	Nova Zembla (Sect. VIII)	Mouth of the Lena (Sect. XIV)
Set completed	23 June 1900[1] *23 June 1898*[2] 24 June 1906[3] 27 June 1910[4] 30 June 1910[4] *30 June 1900*[1] *1 July 1900*[1] 4 July 1910[5] 9 July 1910[5] 16 July 1898[6] 25 July 1923[1] *5 Aug. 1923*[11] (half incubated eggs, Hinlopen Strait)	*8 July 1899*[7] 16 July 1899[7]	Pasvig River *1 June*[8] (West part of Murman coast) *10 June*[8] Yokanga 21 June 1918[12] (East part of Murman coast)	25 June 1897[9]	26 June 1882[10]
Time of hatching	*15 July 1900*[1] 15 July 1898[2] 16 July 1906[3] *18 July 1906*[3] 19 July 1910[4] *22 July 1910*[4] 22 July 1900[1] 23 July 1900[1] *26 July 1910*[5] 31 July 1910[5] 7 Aug. 1898[6] 16 Aug. 1923[11]	30 July 1899[7] *7 Aug. 1899*[7]	Pasvig River 23 June[8] (West part of Murman coast) 2 July[8] Yokanga 13 July 1918[12] (East part of Murman coast)	17 July 1897[9]	18 July 1882[10]
Time when young began to fly	4 Aug. 1900[1] 4 Aug. 1898[2] 5 Aug. 1906[3] *8 Aug. 1910*[4] 11 Aug. 1910[4] 11 Aug. 1900[1] 12 Aug. 1900[1] 15 Aug. 1910[5] *20 Aug. 1910*[5] *27 Aug. 1898*[6] 5 Sept. 1923[11]	19 Aug. 1899[7] 27 Aug. 1899[7]	Pasvig River 13 July[8] (West part of Murman coast) 22 July[8] Yokanga 2 Aug. 1918[12] (East part of Murman coast)	*6 Aug. 1897*[9]	*7 Aug. 1882*[10]

[1] *Fide* Dr. Bunge, Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 320, 1902.
[2] Römer and Schaudinn, Ornith. Monatsb., vol. 8, p. 105, 1900.
[3] Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol. 38, p. 53, 1911.
[4] Zedlitz, Journ. f. Ornith., vol. 59, p. 314, 1911.
[5] Münsterhjelm, Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910.
[6] Kolthoff, Kongl. Svenska Vet.-Akad. Handl., vol. 36, no. 9, p. 77, 1903.
[7] Swenander, Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 26, pt. 4, no. 3, p. 17, 1900.
[8] Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 127, 1903 (in Russian).
[9] Pearson, Ibis, ser. 11, vol. 4, p. 202, 1898. [10] Bunge, Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 600, 1883.
[11] Langstaff, Ibis, ser. 11, vol. 6, p. 487, 1924. [12] Coll. Kapustin (Mus. Zool.).

1895 at 84° 32′ north latitude and 80° 30′ west longitude (Collett and Nansen, Norw. North Polar Exp., p. 46, 1899).

CHARADRIIFORMES.

CHARADRIIDAE.

27. Arenaria interpres (Linné).

Plate 37, figs. 11, 12.

Arenaria interpres (Linné). WALTER, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902. BIRULA, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 4–8, 11–16, 66–68, 75, 1907.

Strepsilas interpres. BRUSNEFF, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, pp. 181, 183, 1904.

List of Specimens from the Russian Polar Expedition.

Skins: adult males, 17 and 22 June 1901, west coast of Taimyr Strait (Dr. H. Walter); adult male, three young, 12 July 1902, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff); adult male, female and one young, 18 July 1902, immature, 8 August 1902, Island of New Siberia (A. Birula); adult, 6 June 1901, Wanjkin promontory, Great Ljakoff Island, New Siberian archipelago; two adults, 10 June 1901, Camp Stepanow, Little Ljakoff Island, New Siberian archipelago; adult, 21 June 1901, Camp Michailow, Kotelny Island, New Siberian archipelago (O. Cionglinski); two immature males, 1903, Island of New Siberia; adult with four chicks, 5 July 1903, Bolschaja River, Island of New Siberia; adult, same date and place (M. Brusneff).

Eggs: two, 22 June 1902, Nerpalach, Kotelny Island, New Siberian archipelago; three, 21 June 1902, same place (Dr. V. Katin-Jartzeff); four, 4 July 1903, Bolschaja River, Island of New Siberia (M. Brusneff); two sets of two each, 1 July 1903; two sets of three each, no date, Faddejefski Island, New Siberian archipelago (S. Tolstow); four, no date (auxiliary exped. of Wolosowicz).

Local names: in Samoyede (Kolguev Island), *tu-ik* (Trevor-Battye); in Yakut (Yana region), *tschĕktschengó*; in Tunguse, *tschektschenga* (Birula); at the mouth of the Lena, *tschipu* (Bunge); in Chuckche, *yenatkuatschetlen* (Palmén).

The Turnstone is without doubt a circumpolar species, inhabiting during the breeding season the entire extent of the Arctic seacoasts of the Eurasian tundra region, though obviously in varying abundance. In Spitzbergen (Sect. I) and Bear Island (Sect. II) it has been seen and taken by most explorers but its nesting has not been definitely ascertained, though one must admit that it breeds there occasionally in limited numbers. For the Franz Josef archipelago (Sect. IX) there is but a single accidental record. Along the coasts of the Arctic Ocean this bird, a typical representative of the littoral fauna, breeds in abundance from the Murman coast (Sect. III) on the west to the north coast of the Chuckche peninsula (Sect. XXI) on the east. Data are lacking from the Kanin peninsula (Sect. IV) (where probably travelers have not penetrated to the north coasts on which there would have been more chance of finding this bird nesting) as well as from the mouth of the Indigirka (Sect. XVIII), from the De Long group of islands (Sect. XVII), and Herald Island (Sect. XX). At Wrangel Island, Crawford (Snyder, 1926, p. 14) obtained in 1922 three specimens of the Turnstone which he identified as *Arenaria*

interpres oahuensis (Blexham). It has been recorded breeding on both islands of Nova Zembla (Sect. VIII).

The Russian Polar Expedition did not meet with the Turnstone until the spring of 1901 at the first wintering place of the "Sarja" in Western Taimyr (Sect. XII), because in 1900, at the time of the vessel's arrival, the bird had already left these countries. It was then found to be an abundant nesting bird on all the islands of the New Siberian archipelago (Sect. XVI) visited by the Expedition. In 1901 the auxiliary expedition under Cionglinski found it on Great and Little Ljakoff Islands and on Kotelny Island; in 1902 Dr. Katin-Jartzeff (*in litt.*) observed it on Kotelny Island, and Birula on the Island of New Siberia, while in 1903, Brusneff noted it on the latter island and Tolstow (*in litt.*) on Faddejefski Island.

The following data are at hand as to the time of the Turnstone's arrival in high latitudes: at Yeretiki, western part of the Murman coast (Sect. III), Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) noted its arrival 29 May 1883, 2 June 1884, 31 May 1890, 24 May 1900, and at Alexandrovsk 22 May 1901. According to Schaanning (Dansk. Ornith. For. Tidskr., vol. 10, p. 158, 1926) the Turnstone arrived at Belushja Bay, south island of Nova Zembla, in June, 1903. At the Taimyr (Sect. XII) Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 213, 1853) recorded its appearance in 73° 45′ north latitude on 16 June 1843, while in 1901 at the "Sarja's" winter-quarters the date of its arrival was 10 June (Dr. Walter, 1902, *et in litt.;* Birula, 1907) in small numbers and by 15 June in considerable abundance. In the New Siberian archipelago (Sect. XVI), Birula recorded the first individuals 10 June 1902 on the Island of New Siberia and Tolstow (*in litt.*) on 31 May 1903 on Faddejefski Island.

Birula depicts the habits of the Turnstone in the breeding season in the following words:

> Upon their arrival in the Siberian tundra the Turnstones are paired and at once set about egg-laying. I never have succeeded in finding a nest of this bird chiefly because at the first alarm-notes of its neighbors it leaves its nest and only returns to it when the tundra is once more at peace. One's appearance on the tundra is always proclaimed by a cry of alarm from some Turnstone, *tiwú-tiwú-ti-ti, tiwú-tiwú ti-ti-ti.* At once a pair of these birds follows you, flying from one stone or tuft to another, with importunate cries, until you have gone some distance from the nest. But no sooner have you left the territory of one pair, when a second pair circles about you so that during your entire excursion over the tundra you are pursued by the noisy cries of the Turnstone. One always finds both parent birds near the nest as well as tending the young and the two share equally in protecting their progeny, flying to attack any man or arctic fox that approaches the nest or young. The appearance of a Jaeger (*Stercorarius*) in the neighborhood of the nest and especially near the place where the young are hiding is followed by such a furious attack on the part of the Turnstones that the enemy beats a hasty retreat even when attacked by only a single Turnstone. The uproar in the tundra reaches the highest pitch on the appearance of an arctic fox, and although all the birds of the tundra join in it, the loud notes of the Turnstones predominate. In spite of their social disposition, they do not play a peaceful rôle: in their nesting places, they are seen always either quarrelling with one another or pursuing their neighbors belonging to other

species of shorebirds. On the Island of New Siberia the Turnstones do not show preference for the seashores opposite the more distant parts of the tundra; but on the contrary one finds most of their colonies nesting at a distance from the shores of the sea, chiefly on the mossy slopes of wide, swampy valleys, traversed by a stream or some sort of river. After the young are hatched the Turnstones gather in these valleys with their covering of higher and denser vegetation.

In the western part of the Murman coast (Sect. III) Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130–131, 1903) has found the time of egg-laying to be between 8 and 20 June. For Nova Zembla (Sect. VIII) we have only the observation of Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 61) that the hatching of the young was noted 27 July 1903. In Western Taimyr (Sect. XII) sets were complete 5 July 1901 (Walter, *in litt.*). In the New Siberian archipelago (Sect. XVI) the eggs found by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 277, 1887) on Great Ljakoff Island, 27 June 1886, were partly incubated, while the eggs collected by Tolstow, 27 June 1903, on Faddejefski Island were heavily incubated. Dr. Katin-Jartzeff (*in litt.*) noted the hatching of the young at Nerpalach, Kotelny Island, between 5 and 8 July 1902, but one nest found 22 June contained two eggs and one young bird already hatched. Downy young were found by the same observer on 7 and 12 July, though on the latter date he saw also young birds already beginning to fly. Birula (1907) found a young bird on the Island of New Siberia with its wing- and tail-feathers already well developed on 18 July 1902. Finally Middendorff noted a half-grown young bird in Western Taimyr (Sect. XII) in latitude 75° north on 5 August. Gorbunow (*in litt.*) observed 3 August 1923 and 4 August 1925 young birds able to fly in the Belushja Bay, south island of Nova Zembla (Sect. VIII).

The Russian Polar Expedition has furnished us with the following material as to the nesting of the Turnstone in high latitudes: namely, that the eggs show no differences in comparison with typical eggs of this bird and as regards coloration are of two different types. In the first and more common type the deep olive-buff ground (Ridgway, ed. 2, Pl. 40) or nut brown (avellaneous, *ibid.*, Pl. 40), is almost entirely hidden by very thick superficial spots which in the lighter areas are of a buffy brown (Ridgway, Pl. 40) and in the darker portions of an olive brown. The other and less common type is much less spotted and the deep olive-buff ground obviously predominates. The dimensions and weights of the eggs are:—

1. Two eggs, 22 June 1902, Nerpalach, Kotelny Island, New Siberian archipelago (Dr. V. Katin-Jartzeff): 42 mm. x 29.8 (103 eg.); 42 x 29 (92 eg.).

2. Three eggs, 21 June 1902, same locality and collector: 43.1 mm. x 30 (100 eg.); 43 x 30 (99 eg.); 42.7 x 30 (99 eg.).

3. Four eggs, 4 July 1903, Bolschaja River, Island of New Siberia (M. Brusneff). — The nest was placed at the edge of a pool and was lined with reindeer hair; while the

female was laying the eggs, the male kept at some distance and warned her of the approach of any danger. The eggs were incubated: 39.8 mm. x 27.1 (91 cg.); 38.2 x 27.6 (95 cg.); 39 x 27.3 (93 cg.); 37 x 27 (88 cg.).

4. Two eggs, 1 July 1902, Faddejefski Island, New Siberian archipelago (*S. Tolstow*).—In all, S. Tolstow found on 1 July 1903 seven sets of eggs. The nests for the most part were nothing more than slight hollows between tufts of moss, though in one case a sort of burrow, and in another instance resembling a Gull's nest, carefully lined with dry peat and fine grasses and having a depth of 4.5 cm. The eggs were heavily incubated: 40 mm. x 28.6 (97 cg.); 40 x 28.8 (99 cg.).

5. Two eggs, 1 July 1903, same data and collector: 40 mm. x 28 (110 cg.); 40.1 x 27.6 (105 cg.).

6. Three eggs, 1 July 1903, same data as before: 40.3 mm. x 27.1; 41.2 x 28.9; 41 x 28.

The Russian Polar Expedition succeeded in determining the most peculiar fact of the very early departure of the Turnstones from high latitudes. In 1900 the Expedition, in visiting Dickson Bay at the mouth of the Yenisei (Sect. XI) on 12 August and later Western Taimyr (Sect. XII), no longer found the Turnstone, which had evidently already left those latitudes. In Dr. Walter's journal (MS.) I find the following notes for the year 1901; 4 August they had quite disappeared; 6 August and 8 August not a single one seen; 9 August a family group seen; 12 August some single birds. From all these observations Dr. Walter concluded that the Turnstones leave as soon as the young are strong on the wing. These results are quite in agreement with the observations of Birula (1907) in 1902 on the Island of New Siberia, for the departure of the Turnstone was so hurried and lasted so short a time that this naturalist did not succeed in determining the dates of their leaving. The 14 August he saw the last small flock of these birds and the next day nothing but solitary individuals. Middendorff (1853) noted that the Turnstone left Taimyr 22 August 1843 and Miss Haviland (Ibis, 1915, p. 396) observed the first of the small flocks of migrants on their return passage at Golchiha, mouth of the Yenisei on 12 August 1914, and the days following. Schaanning (Dansk. Ornith. For. Tidskr., vol. 10, pp. 150, 158, 1926) informs us that in 1902, the Turnstone had left Nova Zembla before 10 August.

Arenaria melanocephala (Vigors).—The Black-headed Turnstone is recorded from the extreme eastern portions only of the Eurasian tundra. Nelson (Cruise of the Corwin, p. 83, 1883) saw small flocks of these birds, 1 August, in the vicinity of Wrangel and Herald Islands (Sect. XX) but did not find them again on these islands. The possibility of their occurrence in these regions may be admitted in view of the fact that Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 24, 1914) saw them on his last journey, 15 August 1912, in Chaun Bay (Sect. XIX).

Haematopus ostralegus Linné.—In Spitzbergen (Sect. I) and on Bear Island (Sect. II) the Oystercatcher has been detected only by Professor Mathey-Dupraz (Bull. Soc. Sci. Nat. Neuchâtel, vol. 38,

p. 46, 1911) who tells us that a specimen was killed in July 1906, in Advent Bay, Spitzbergen, and a second one seen 28 July 1910 near the vessel in the neighborhood of Bear Island. On the littoral of the Murman coast (Sect. III) this species regularly breeds in some numbers and represents a form characteristic of the fauna of this shore. Farther to the eastward it has not been recorded except from the Kanin peninsula (Sect. IV).

28. **Squatarola helvetica** (Linné) (=**squatarola** (Linné)).

Squatarola helvetica (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 155, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 4, 5, 7, 15, 66, 68, **70**, 1907.

List of Specimens from the Russian Polar Expedition.

Skin: adult male, 22 August 1901, west shore of Taimyr Strait (Dr. H. Walter).
Eggs: four, 6 July 1901, and four, 15 July 1901, same locality and collector.

Local names: in Samoyede (Kolguev Island), *doo-lissia* (Trevor-Battye); in Yakut, *collit;* in Tunguse, *kikauke* (Birula).

The Gray Plover breeds in the Eurasian tundra zone of the mainland from the Kanin peninsula (Sect. IV) in the west to the mouth of the Kolyma (Sect. XIX) on the east. On the Murman coast (Sect. III) one finds only single birds (the Kapustin collection contains a female killed 8 June 1916 at Yokanga) chiefly, as one must suppose, during the migration seasons. As a regular breeding bird it has been found in the islands of the Arctic Ocean only on Kolguev (Sect. V) and Great Ljakoff (Sect. XVI), while from the south island of Nova Zembla (Sect. VIII) we have only two records of its accidental appearance, of which that of 22 June 1924, from Meshdusharski Island is designated as doubtful by the author himself (Jordans, Journ. f. Ornith., vol. 73, p. 451, 1925). Finally, Crawford (Snyder, Univ. Toronto Studies, biol. ser., no. 28, p. 13, 1926) secured three adults of the Gray Plover at Wrangel Island (Sect. XX) which Snyder referred to the subspecies *S. squatarola hypomelas* (Pallas). I have undertaken to measure a series of East Siberian specimens in our Zoölogical Museum and find that the length of their wings varies between 192 and 198 mm., so that they agree completely with the western form.

The Russian Polar Expedition found the Gray Plover nesting in considerable numbers in the vicinity of the "Sarja's" first winter-quarters on the west coast of the Taimyr peninsula (Walter, 1902; Birula, 1907). During his stay in 1902 on the Island of New Siberia, Birula (1907) saw a single bird 2 August in a flock of *Crymophilus fulicarius* (Linné); he also learned from the natives who accompanied him that the Gray Plover breeds in abundance at the mouth of the Yana and on Great Ljakoff Island. According to Dr. Walter the two first specimens of this Plover were noted at the "Sarja's" winter-quarters in Western Taimyr 15 June 1901 (*in litt.*) although in his published works (1902) he places the date of its arrival in 1901 on 18 June.

Two sets of eggs were found by the members of the Russian Polar Expedition. Each set comprised four incubated eggs, which in respect to their coloration do not differ from other eggs of this species in our Zoölogical Museum. Their measurements and weights are:

1. Four eggs, 6 July 1901, west coast of Taimyr Strait (Dr. H. Walter): 52.5 mm. x 35 (153 cg.); 52.6 x 35.1 (178 cg.); 51.1 x 35 (167 cg.); 51.7 x 35 (164 cg.).

2. Four eggs, 15 July 1901, same place and collector: 52.8 mm. x 36.1 (201 cg.); 52.4 x 37 (228 cg.); 53 x 37.6 (211 cg.); 54.6 x 37.8 (225 cg.).

According to Dr. Walter's journal the old birds to which these sets belonged were very solicitous for their eggs, but remained at a distance, very shy, as is their habit. In both cases it was the male that after a rather long wait, first made bold to approach the nest. The nests, made of lichen, were situated among stones and were quite invisible to the eye—thanks to the coloration of the eggs which is very nearly of the same tint as the soil.

Between 4 and 5 July 1884, Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 278, 1887) found in the vicinity of Sagastyr, at the mouth of the Lena, two sets of two eggs each, evidently quite fresh; these therefore should have been completed about 7–8 July. In placing the incubation period at 27 days,—in accordance with the result obtained by Evans (Ibis, 1891, p. 79) for the Golden Plover, *Charadrius pluvialis*, by the use of an incubator,—these sets should have hatched about 2–3 August.

The only data at hand as to the time of the Gray Plover's departure from the Siberian tundra consists in the testimony of Miss Haviland (Ibis, 1915, p. 397) to the effect that a severe storm followed by a gale on 27 August 1914 drove most of the summer birds including this Plover from the vicinity of Golchiha (at the mouth of the Yenisei).

In the region at the mouth of the Lena, Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 598, 1883) observed flocks of this species on migration on 10, 11 and 12 September and the last individuals 17 September 1882.

Charadrius pluvialis Linné (=**apricarius** Linné).—*Local name:* in Samoyede (Yamal peninsula), *jaipyre* (Zitkow). During the breeding season the Golden Plover inhabits not only the moss-covered marshes of the subalpine and in part even of the forest region, but also must be included among the species of the tundra fauna belonging to the alpine region. It has been recorded to the number of probably two pairs on Bear Island (Sect. II) in 1921 (Jourdain, Ibis, 1922, p. 170); as breeding along the Murman coast (Sect. III), in the Kanin peninsula (Sect. IV), on Kolguev Island (Sect. V) and on Vaigach Island (Sect. VII) and in the regions about the mouths of the rivers Pechora (Sect. VI), Ob (including the Yamal peninsula) (Sect. X) and Yenisei (Sect. XI). In the two last sections it occurs in company with *Charadrius dominicus fulvus* Gmelin, which according to Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 332, 1912) reaches the western limit of its geographic distribution in the Yamal peninsula. In the southern island of Nova Zembla, the Golden Plover has been noted only in Chystina Harbor by Col. Feilden (Markham, A Polar Recon. of the "Isbjörn," p. 326, 1881).

The Russian Polar Expedition probably did not meet with this species, for I presume that the birds seen, but not taken, by Dr. Walter (1901) in Western Taimyr (Sect. XII) 6 September 1900, were probably referable to the Eastern or Lesser Golden Plover.

29. Charadrius dominicus fulvus Gmelin.

Charadrius pluvialis. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901.

List of Specimens from the Russian Polar Expedition.

Skins: three adults, 6 June 1902, Charaulach Mountains, mouth of the Lena (M. Brusneff).
Eggs: four, 23 June 1902, mouth of the Elijdep River, Charaulach Mountains (M. Brusneff).

Local name: in Yakut, *kulit* (Bunge).

The Lesser Golden Plover, an Asiatic race of the American species, *Charadrius dominicus* Müller, inhabits the Siberian coasts of the Eurasian Arctic Ocean from the Yamal peninsula (Sect. X) and the mouth of the Yenisei (Sect. XI) (breeding in association with the Common Golden Plover, *Charadrius pluvialis* Linné); according to Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 210, 1853, sub *Char. pluvialis* Linné) it occurs in Taimyr (Sect. XII), in the region of the Lena's mouth (*fide* Bunge, Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 598, 1883; vol. 12, p. 57, 1888; Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 123 *et seq.*, 1887) and specimens were collected by Brusneff of the Russian Polar Expedition in the Charaulach Mountains, 1902, on the Ljakoff Islands of the New Siberian archipelago (Sect. XVI) (Bunge, p. 275, 1887, sub *Ch. pluvialis*); at the mouth of the Kolyma (Sect. XIX) and it is of accidental occurrence on Wrangel Island (Sect. XX) (Nelson, Cruise of the Corwin, p. 94, 1883). The specimens secured by the "Vega" Expedition on the north coast of the Chuckche peninsula (Sect. XXI) are referred to the American form on the basis of their measurements as Professor Palmén has shown (Sibir. Ishafsk. Fogelf., p. 342 *et seq.*, 1887). Nevertheless the Asiatic form must occur regularly in these regions on its migration to pass in autumn along the eastern coasts of Asia to its wintering places and on its return passage in the spring. Dr. Walter (1901) noted the occurrence of a Golden Plover 6 September 1900 in Western Taimyr (Sect. XII) but he was unable to secure specimens. He determined it provisionally as *Charadrius pluvialis* but I presume that it was in reality the Asiatic form of this Plover, *Charadrius dominicus fulvus* Gmelin. On the islands of the New Siberian archipelago no representative of the Golden Plover was discovered by the Russian Polar Expedition. Only the auxiliary expedition under Brusneff found Golden Plovers on the Siberian mainland in the Charaulach Mountains (Sect. XIV). The three specimens taken by him show the following measurements, from which they must undoubtedly be referred to the Asiatic form, *Charadrius dominicus fulvus* Gmelin.

	Culmen	Wing	Tail	Tarsus
1. Adult, 6 June 1902, Charaulach Mts. (Brusneff)	23	165	59.5	40.1 mm.
2. " " " " " "	24	164	62.0	42.0 mm.
3. " " " " " "	25.5	165	61.0	44.5 mm.

On 23 June 1902 Brusneff likewise succeeded in finding a set of eggs of the Lesser Golden Plover at the mouth of the Elijdep River, Charaulach Mts. These eggs show the following measurements and weights: 48.9 mm. x 33.3 (150 cg.); 48 x 33 (130 cg.); 47 x 33.6 (146 cg.).

In color the eggs show no peculiarities. Koren (Thayer and Bangs, 1914) collected two sets of eggs of this bird on 30 June 1912 at the mouth of the Kolyma and two others on 5 July 1912 at Cape Bolschoi Baranovski, containing young almost ready to hatch.

Charadrius dominicus dominicus Müller.—The two specimens of Golden Plovers obtained by the "Vega" Expedition in the neighborhood of that vessel's winter-quarters on the north coast of the Chuckche peninsula (Sect. XXI) are from their dimensions referable to the American form, as Professor Palmén has shown (Sibir. Ishafsk. Fogelf., p. 342, 1887).

30. Eudromias (=Charadrius) morinellus (Linné).

Eudromias morinellus (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 155, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 4, 67, 69, 1907.

Charadrius morinellus. Toll, Die russ. Polarf. d. "Sarja," pp. 315, 336, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: immature male, 13 August 1900, adult male, 14 August 1900, Dickson Bay, mouth of the Yenisei (Dr. H. Walter); adult male, 18 June 1901, two adult males, 11 July 1901, west shore of Taimyr Strait (Dr. H. Walter); adult male and female, 5 June 1902, Charaulach Mts., mouth of the Lena (M. Brusneff).

Eggs: two, 11 July 1901, west shore of Taimyr Strait; three, same date and place (Dr. H. Walter).

Local name: in Chuckche, *pekongadlj* (Palmén).

The Dotterel inhabits the tundra zone along the shores of the Eurasian Arctic Ocean from the Murman coast to the north coast of the Chuckche peninsula, as well as some of the islands of this ocean adjacent to the mainland and not too far to the north. In Spitzbergen (Sect. I) Keilhau (Reise i Öst- og Vest-Finm., Beeren-Eil. u. Spitzb., p. 163, 1831) found one dead; but Professor König (Avif. Spitzb., p. 161, 1911) is doubtful of this and eliminates the species from the list of birds found in Spitzbergen. I prefer to re-establish it with reservation, since the accidental occurrence of this species in Spitzbergen is readily admissible. The Dotterel has not been found hitherto in the Kanin peninsula (Sect. IV) but probably nests there, since it has been recorded from Kolguev Island (Sect. V), Vaigach Island (Sect. VII) and the two islands of Nova Zembla (Sect. VIII). Along the Siberian coasts of the Arctic Ocean it has been found everywhere, on the shores of the Kara Sea (Sect. X), at the mouth of the Yenisei (Sect. XI), in Western Taimyr (Sect. XII) and Eastern Taimyr (Sect. XIII)—(noted by the Hydrographic Expedition to the Arctic Ocean 22 August 1913 in Chatanga Bay—then in Dick Bay, (76° 48′ north latitude, 100° 50′ east longitude, and at 76° 40′ north, 100° 58′ east), and

finally in the mouth of the Lena (Sect. XIV). We have no records at hand from the region of the Yana (Sect. XV) and the Indigirka (Sect. XVIII), but it seems quite possible that the bird frequents also these parts of the north coast of Siberia. It is found again on the Ljakoff Islands and on Wassiljefski Island, one of the group of "Little Islands" (Sect. XVI), whence Dr. Arnhold, surgeon of the transport "Vaigach" of the Hydrographic Expedition to the Arctic Ocean, brought back an immature male of this species, taken 19 August 1912. It has also been found in the region of the Kolyma and on the "Island of the Four Posts", one of the Medweshi group (Sect. XIX), whence the members of the Hydrographic Expedition under Captain Wilkitzky, Dr. L. Starokadomski, surgeon of the transport "Taimyr," and Dr. E. Arnhold, surgeon of the transport "Vaigach," brought back specimens taken 30 July 1912 and 13 August 1913. Finally, this bird has been recorded from the north coast of the Chuckche peninsula (Sect. XXI) by the "Vega" Expedition (Palmén, Sib. Ishafsk. Fogelf., p. 338, 1887).

The Russian Polar Expedition first met with the Dotterel 13 August 1900 on Kuzkin Island, opposite Dickson Bay, where Birula (1907; Walter, 1901, *et in litt.*) procured a young bird not yet fully grown. In 1901 the Dotterel was found breeding in numbers about as great as *Squatarola helvetica* (Linné) in the neighborhood of the "Sarja's" first winter-quarters on the western coast of Taimyr (Walter, 1902; Birula, 1907; Toll, 1909). Finally, the auxiliary expedition of 1902 under Brusneff found this species on the mainland in the latitudes of the mouth of the Lena, in the Charaulach Mountains.

The time of the Dotterel's first appearance in high latitudes has not been noted for a series of years except on the Murman coast (Goebel, Ornith. Jahrb., vol. 12, p. 214, 1901) in the following places: at Yeretiki, 28 May 1883, 2 June 1884, 5 June 1899, 26 May 1900; and at Alexandrovsk, 30 May 1901. In the vicinity of Matochkin-shar, Nova Zembla, the Dotterel was for the first time recorded 13 June 1903 by Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 60). Dr. Walter (1902) in his published works states that it appeared in 1901 in Western Taimyr about the middle of June, corresponding to 13 June 1901, the date when according to Birula (1907, p. 4) the first specimen was taken. Baron Toll noted and procured his first specimen 14 June and Dr. Walter (*in litt.*) recorded 15 June in his diary as the day when this bird arrived. Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 211, 1853) recorded its appearance in Taimyr, in 73° 45′ north latitude, 16 June 1843.

Dr. Walter (1902) secured in Western Taimyr on 11 July 1901, two sets of eggs of the Dotterel, one of which contained three incubated eggs and the other four, heavily incubated. On both nests he found the female which made frantic efforts to draw the attention of the observers from the eggs, but returned then to them at once. The nests

were rather cleverly situated in the midst of rock débris but were almost altogether without any nest material so that in one case the eggs were laid directly on pebbles. The eggs of the two sets are of the usual coloration and present the following measurements and weights.

1. Three eggs, incubated, 11 July 1901, west coast of Taimyr (*Dr. H. Walter*): 40 mm. x 28 (77 eg.); — x 28.6 (——); — x 28.1 (83 eg.).

2. Two heavily incubated eggs, 11 July 1901, same place and collector: 40.2. mm. x 29; 40.6 x 28.5.

According to the observations of Bilkiewicz (App. to the Scient. Results Exped. Univ. Kasan, p. 26, 1904 (in Russian)) the young Dotterels on the southern island of Nova Zembla were still unable to fly on 25 July 1904.

As to the time of their departure from high latitudes we have only the two following statements: Schaanning (Dansk. Ornith. For. Tidskr., vol. 10, pp. 150, 158, 1916) arriving at Matochkin-shar, Nova Zembla, 13 August 1902, could not detect any trace of the Dotterel and supposes that they had gone before 10 August; Middendorff (1853) writes that the Dotterels left the Byrranga Mountains of Taimyr peninsula by 27 August 1843.

Aegialitis (= Charadrius) semipalmatus (Bonaparte).—Nelson (Cruise of the Corwin, p. 84, 1883) is the only one who has recorded this species of Plover from the north coast of the Chuckche peninsula (Sect. XXI) and particularly from Koljuchin Bay. The "Vega" Expedition did not find it in the neighborhood of its winter-quarters.

Aegialitis (= Charadrius) hiaticula hiaticula (Linné).—Dr. Hartert (Die Vögel der palaearkt. Fauna, vol. 2, p. 1533, 1915) presumes that from the measurements taken by Dr. Du-Roy (of the König Expedition) the Spitzbergen bird pertains to the typical form of Ringed Plover; we may admit further that the bird of Bear Island probably appertains to the same subspecies. A revision of the collections of our Museum has persuaded me that only specimens from the eastern coasts of the Baltic Sea have a longer wing and a paler upper surface, whereas the birds killed in the vicinity of Petrograd, on the shores of the Gulf of Finland, as likewise those from the entire northern part of European and Asiatic Russia, belong to the eastern subspecies, *Aegialitis (= Charadrius) hiaticula tundrae* Lowe.

According to Professor König (Avif. Spitzb., p. 161, 1911) the Ringed Plover breeds regularly though in limited numbers in Spitzbergen (Sect. I) and appears rarely also on Bear Island (Sect. II) during the breeding season. Nansen (Collett and Nansen, Norw. North Polar Exp., p. 45, 1899) records that the Ringed Plover was found to the north of Spitzbergen on 13 June 1896, in 82° 59′ north latitude; the exact definition of the subspecies rests in this case unknown.

31. **Aegialitis (= Charadrius) hiaticula tundrae** Lowe.

Aegialitis hiaticula. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901.
Charadrius hiaticula. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 1, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: two adult males, two adult females, 17 June 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff); adult, 8 July 1903, Camp Yelesseyeff, Kotelny Island (P. Olenin).
Eggs: four, 8 July 1903, Camp Yelesseyeff, Kotelny Island (P. Olenin).

Local names: in Yakut, *tschugujúk* (Bunge); in Chuckche, *argitodljakidlin* (Palmén).

The eastern subspecies of the Ringed Plover nests regularly along the coast of the Arctic Ocean from Russian Lapland (Sect. III) to the mouth of the Lena River (Sect. XIV), as well as on Kolguev (Sect. V), Vaigach (Sect. VII) and on the two islands of Nova Zembla (Sect. VIII, a and b) and reappears once more in the latitudes of the mouth of the Kolyma (Sect. XIX) and on the north coast of the Chuckche peninsula (Sect. XXI). In the archipelago of New Siberia (Sect. XVI) it is apparently rare and has been recorded only by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 274 *et seq.*, 1887) on Great Ljakoff Island, twenty kilometers north of Stolbowoi Island (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 57, 1888, sub *Ch. curonicus*) and on Kotelny Island by Olenin. The Russian Polar Expedition did not find the Ringed Plover except on the Siberian mainland, on the Elijdep promontory, in the latitudes of the mouth of the Lena (Brusneff), and on Kotelny Island whence Olenin brought back not only an adult bird but a set of eggs as well, taken 8 July 1903 in the vicinity of Camp Yelesseyeff.

For arrival dates of the Ringed Plover in the high latitudes we have the following notes of Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) for the Murman coast: at Yeretiki this Plover appeared 28 May 1883, 5 June 1899, and 30 May 1900; and at Alexandrovsk, 6 June 1901 and at Kola, 17 May 1901; as well as the notes of Schaanning (Dansk. Ornith. For. Tidskr., vol. 10, pp. 150, 158, 1916) of its arrival 5 June 1903 at Matochkin-shar, Nova Zembla, and of Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 213, 1853) for the Taimyr River where in 74° north latitude it appeared in mid-June.

Goebel states (Mém. Soc. Nat. St. Pétersbourg, vol. 23, p. 130–131, 1902) that the eggs are laid in the Pasvig River basin between 10 and 27 June, that is, in the middle and latter parts of the month; and in the western part of the Murman coast (Zip-Navolok, Yeretiki, Alexandrovsk) egg-laying takes place between 26 June and 1 July or toward the last days of June, and well-incubated eggs have been found there about 13 July. Middendorff found eggs in Taimyr 22 July. During the expedition of the brothers Kusnetzow into the north part of the Ural, Wardropper, the naturalist of the party, took young birds in down 25 and 26 July 1909, in the vicinity of Mt. Manisei and between the latter and the Kara River (specimen in our Zoölogical Museum). These dates correspond with the date of a similar find in Belushja Bay, south island of Nova Zembla, 25 July, by Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 311, 1908) while young Plovers found 29 July by Bilkiewicz (App. Mém. Exped. Univ. Kasan, p. 19, 1904) on the shores of Promyslowaja River were partially though not fully feathered. According to Gorbunow (*in litt.*) the young ones, fully feathered, were able to fly 16 August 1923.

The departure of the Ringed Plover in autumn has been noted on Nova Zembla by Bilkiewicz (1904) about 23 August, by Schaanning (1916) 18 August 1902, and by Gor-

bunow (*in litt.*) in 1923 in the last days of this month and in 1924 in the beginning of September. At the mouth of the Yenisei these birds, according to Miss Haviland (Ibis, 1915, p. 397) remained at Golchiha until 3 September 1914 and Middendorff (1853) observed the last birds in Taimyr in 74° 30′ north latitude, on 24 August 1843.

Numenius phaeopus (Linné).—*Local name:* in Samoyede, on Kolguev Island, *arki-sierrk* (Trevor-Battye). The Whimbrel belongs to the fauna of the western parts only of the coasts of the Eurasian Arctic Ocean. Professor König (Avif. Spitzb., p. 163, 1911) lists three instances of its occurrence in Spitzbergen (Sect. I) and Römer and Schaudinn (Fauna Arctica, p. 69, 1900) have once recorded it for Bear Island (Sect. II). Of these four records, in two cases, the birds were found dead, which makes one suppose that their visits to the countries mentioned cannot be of regular occurrence and that they easily succumb to the strain of the long journey. Lately, Professor Mathey-Dupraz in June 1906, killed two males and a female at Advent Bay, Spitzbergen (Bull. Soc. Sci. Nat. Neuchâtel, vol. 38, p. 46, 1911) and on 28 July 1912, on the seashore at Smeerenburg (*ibid.*, vol. 39, p. 98, 1913) he saw a pair which from their actions must have had either eggs or very young birds. Finally Dr. Van Oordt saw an individual at Cape Boheman 26 June 1921 (Jourdain, Ibis, 1922, p. 172).

On the Murman coast (Sect. III) this bird, as a representative of the fauna of the subalpine region, appears generally and occasionally nests in limited numbers in places where this region extends to the shores of the Arctic Ocean. It is recorded also from Kolguev Island (Sect. V) and finally a Curlew, the species of which was not precisely determined, was seen in the Kanin peninsula (Sect. IV); since, however, the Common Curlew—*Numenius arquatus* (Linné)—cannot be supposed in this case, it could only have been the Whimbrel. The Russian Polar Expedition did not see any Curlews during its voyage.

Numenius borealis (Forster).—Nelson (Cruise of the Corwin, p. 90, 1883) on 6 August 1881 saw four Curlews at Cape Vankarema, north coast of the Chukche peninsula (Sect. XXI), which he identified as *Numenius borealis* (Forster). I quite agree with Professor Palmén (Sibir. Ishk. Fogelf., p. 301, 1887) that an identification of these American Curlews in flight cannot be regarded as sufficiently positive, but I think that he is quite wrong in supposing that they might have been of the European species, *Numenius phaeopus* (Linné), since the latter has not been recorded farther to the eastward than the Kanin peninsula.

32. **Limosa lapponica lapponica** (Linné).

Limosa lapponica (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 155, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 5–6, 67, **93**, 1907 (*partim*, from Western Taimyr). Toll, Die russ. Polarf. d. "Sarja," p. 68, 1909.

List of Specimens from the Russian Polar Expedition.

Skin: ? immature female, 24 August 1900, Western Taimyr (Dr. H. Walter).

Local name: in Samoyede (Taimyr), *tuffoka* (Middendorff).

The Bar-tailed Godwit during the breeding season frequents, in limited numbers, those parts of the coasts of the Eurasian Arctic Ocean where the subalpine zone reaches the seashore from the Murman coast on the west to the mouth of the Lena on the east. It has been found particularly on the Murman coast (Sect. III), possibly on the Kanin peninsula (Sect. IV), and on Kolguev Island (Sect. V). Seebohm (Ibis, 1876, p. 292) met with it at the mouth of the Pechora (Sect. VI) but identified it as *Limosa aegocephala* (Linné). Along the Yenisei (Sect. XI) it has been noted by Popham (Ibis, 1898, p. 518)

and by Lawrow (Mém. Soc. Nat. Univ. Kasan, vol. 41, pt. 4, p. 27, 1909) as far north as latitude 72° and in Western Taimyr (Sect. XII) by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 217, 1853) as far as 75° north latitude and again by the Russian Polar Expedition. Finally, Dr. Bunge brought back a specimen killed in mid-August at Sagastyr at the mouth of the Lena (Sect. XIV); this is now in our Museum and I have verified the determination.

The Bar-tailed Godwit has been recorded in autumn up to 14 September 1900 by Dr. Walter (1901), Birula (1907) and Baron Toll (1909) in various places in Western Taimyr, such as Minin and Middendorff Bays. Middendorff (1853) felt certain that this species nested in Taimyr, but on the other hand Walter and Birula were quite agreed from their observations that it was not breeding in 1901 in the vicinity of the "Sarja's" winter-quarters.

In this year the Bar-tailed Godwit, writes Birula (1907), did not appear until 2 July, when large flocks numbering from 70 to 100 birds were seen and among them a considerable number of *Tringa canutus*. Such a flock, for example, I saw 21 July, that is, at a time when the nesting of the Knot was still in full swing. All the birds of this flock were in full adult summer plumage. We must therefore presume that these flocks consisted of Godwits and Knots of a year old that had not yet nested. On 24 July, I saw similar flocks that were already on their way southward. During their nomadic life the flocks of *Limosa lapponica* perform such characteristic evolutions that there is no difficulty in distinguishing a flock of Bar-tailed Godwits from similar flocks of other shorebirds. On 5 July I had an opportunity of watching for a long time such a flock as it flew about over Bonnevie Island near the "Sarja's" anchorage. It was a large company consisting of at least seventy birds. For a long while it swept back and forth with loud cries, sometimes rising to a considerable height, again almost touching the ground, then dashing sharply to one side and once more rising to a height. These swift evolutions are quite characteristic of these wandering flocks.

According to Dr. Walter (1902) these roving bands after 12 September contained a certain number of young birds.

So few are the data available on the periodic phenomena in the life of the Bar-tailed Godwit at high latitudes that we can hardly draw conclusions from them. I shall therefore confine myself to presenting such as relate to Taimyr. Middendorff (1853) states that this species made its appearance 15 June on the Taimyr River, 74° north latitude, laid its eggs in mid-July and that the last birds left the latitudes of 75° north by 23 August. In 1900 the greater part of the Bar-tailed Godwits had left Middendorff Bay in Taimyr about 6 September (Walter, 1901; Birula, 1907) and the last one was seen by Dr. Walter (*in litt.*) 14 September.

33. Limosa lapponica novae-zealandiae Gray.

Limosa lapponica (Linné). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 93, 1907 (*partim*, from shores of the Yana).

List of Specimens from the Russian Polar Expedition.

Skin: adult, 15 July 1902, Besborodowka River, Kotelny Island (Dr. V. Katin-Jartzeff).

Local names: Since I presume that the region of the Yana (Sect. XV) is inhabited by the eastern form of the Bar-tailed Godwit (*Limosa lapponica novae-zealandiae* Gray), I refer to this race the names in Yakut and Tunguse, collected by Birula. In Yakut it is called *kurhachi;* in Tunguse, *küdok-ekenny*, which means literally, sister of the White Crane [*Sarcogeranus leucogeranus* (Pallas)].

In the east, *Limosa lapponica novae-zealandiae* Gray replaces the western form of Bar-tailed Godwit from the mouth of the Yana (Sect. XV). Likewise on the islands of the New Siberian archipelago (Sect. XVI) it is only this form that has been taken and noted as probably breeding by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 332, 1887) on Great Ljakoff Island (specimen in our Zoölogical Museum, female, 3 July 1886) as also on the River Besborodowka, Kotelny Island, where a specimen was killed 16 July 1902, by Dr. Katin-Jartzeff. Farther east this bird has been recorded from the mouth of the Indigirka (Sect. XVIII) by Sensinow (Zitkow and Sensinow, Journ. Sec. Zoöl. Soc. Friends Nat. Sci., p. 9, 1915, in Russian) and of the Kolyma (Sect. XIX) by Buturlin (Ibis, 1906, p. 134).

Finally, from the north coast of the Chuckche peninsula (Sect. XXI) it is listed but not found by Nelson (Cruise of the Corwin, p. 89, 1883), has been recorded by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 19, 1914) 18 July 1912 at Cape Bolschoi Baranovski and 19 July 1912 at Balagan and on the same Cape Bolschoi Baranovski (Sect. XIX) 9 August 1915 by Amory (Riley, Proc. U. S. Nat. Mus., vol. 54, p. 614, 1918).

Macrorhamphus griseus scolopaceus (Say).—This species has been found on the northern coast of the Chuckche peninsula (Sect. XXI) only: first, a male 20 June at Jinretlen and a female 23 June 1879 at Pitlekaj by members of the "Vega" Expedition (Palmén, Sib. Ishk. Fogelf., p. 302, 1887); and again in abundance in the vicinity of Cape Vankarema by Nelson (Cruise of the Corwin, p. 85, 1883). It was not found by the Russian Polar Expedition in the places visited.

Totanus fuscus (Linné)(=**Tringa erythropus** (Pallas)).—The Dusky Redshank evidently does not belong to the Eurasian tundra fauna, but occurs at times accidentally and may even nest there in those places where the subalpine zone nears the shores of the Arctic Ocean. Under these conditions it has been recorded from the Murman coast (Sect. III) and from the mouth of the Yenisei (Sect. XI) (Popham, Ibis, 1898, p. 518; Lawrow, Mém. Soc. Nat. Univ. Kasan, vol. 41, no. 4, p. 21, 1909). On Kolguev Island (Sect. V) a Redshank has been seen, but it is a question whether it was *Totanus fuscus* (Linné) or *Totanus calidris* (Linné). According to Jordans (Journ. f. Ornith., vol. 73, p. 451, 1925) two specimens of the Dusky Redshank were obtained in 1924 on Nova Zembla (Sect. VIII).

Totanus calidris (Linné) (=**Tringa totanus** (Linné)).—The conditions under which this species occurs in the Eurasian tundra are quite the same as for the preceding species. The Redshank has been observed on the Murman coast (Sect. III) and possibly also on Kolguev Island (Sect. V).

Heteractitis (=**Tringa**) **incanus** (Gmelin).—Only once recorded from the Eurasian tundra region. On 1 June 1879 Dr. Almquist succeeded in obtaining one specimen in the vicinity of the winter-quarters of the "Vega," on the north coast of the Chuckche peninsula (Sect. XXI).

Tringoides (=**Tringa**) **hypoleucos** (Linné).—The Common Sandpiper is an inhabitant of the forest region and appears only accidentally in the tundra zone. It has been recorded in Russian Lapland (Sect. III) and at the mouth of the Yenisei (Sect. XI) in 71° 40′ north latitude.

Tringoides (=**Tringa**) **macularia** (Linné).—A specimen of the Spotted Sandpiper was killed previous

to 1844 in Spitzbergen (Sect. I) and presented by the Admiralty to the British Museum of Natural History at London (Sharpe, Cat. Birds Brit. Mus., vol. 24, p. 468, 1896). Professor König (Avif. Spitzb., p. 170, 1911) suggests the possibility of a confusion of labels and for this reason expunges the species from the list of Spitzbergen birds. Since this American species has been found casually in different places of the western parts of Europe, its accidental occurrence in Spitzbergen is quite possible and I see no sufficient reason for eliminating it from the fauna of this archipelago.

?Glottis(=Tringa) nebularius (Gunnerus).—Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 599, 1883) records this bird from the mouth of the Lena (Sect. XIV). Since I have not succeeded in finding in our Zoölogical Museum a specimen of this species collected by that naturalist, I feel obliged to list it with a question, as it is a bird that may reach the Eurasian tundra altogether exceptionally. Professor Nansen (Collett and Nansen, Norw. North Polar Exp., p. 7, 1899) believes that he saw a bird of this species 8 August 1878 on the Yamal peninsula (Sect. X), 69° 37′ north latitude and again on Renö Island, one of the islands of the Kjellman archipelago, in Western Taimyr (Sect. XII).

34. **Pavoncella (=Philomachus) pugnax** (Linné).

Pavoncella pugnax (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 2, 9, 67, 68, 70, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: young, 7 August 1900, Vaigach Island; young male, 24 August 1900, Western Taimyr (Dr. H. Walter); adult male, spring plumage, 1 June 1901, Camp Stepanow, Faddejefski Island, found dead (O. Cionglinski); adult male, spring plumage, and adult female, 17 June 1901, Elijdep promontory, Charaulach Mts., mouth of the Lena (M. Brusneff).

Local names: in Samoyede (Kolguev Island), *lorr-söw* (Trevor-Battye); in Yakut, *barach* or *selljach-barach*, that is, Sandpiper with a ruff (*sellj* = ruff, *baraeh* = Sandpiper); in Tunguse, *panga* (Birula).

Since the Ruff is a bird of the forest, subalpine and even alpine areas, it appears as a breeding species in the Eurasian tundra from the Murman coast (Sect. III) to the mouth of the Kolyma (Sect. XIX) in the east, as well as on the adjacent islands, as on Kolguev Island (Sect. V), Vaigach (Sect. VII), and accidentally and rarely on several islands of the New Siberian archipelago (Sect. XVI). It is absent altogether from Spitzbergen (Sect. I), Bear Island (Sect. II), the Franz Josef archipelago (Sect. IX) and Nova Zembla (Sect. VIII) and it has not been certainly recorded in the eastern part of the Taimyr peninsula (Sect. XIII). On Sucharin Island, Kolyma delta (Sect. XIX), Amory (see Riley, Proc. U. S. Nat. Mus., vol. 54, p. 615, 1918) took five females of the Ruff, 7 and 9 July 1915.

The Russian Polar Expedition (Walter, 1901, *et in litt.;* Birula, 1907) found the Ruff on Vaigach Island (Sect. VII) 7 August 1900, on Kuzkin Island, opposite Dickson Bay (Sect. XI) 12 August 1900 and in Middendorff Bay, Western Taimyr (Sect. XII) between 24 August and 14 September 1900. In 1901 the Ruff was not met with in the neighborhood of the "Sarja's" first winter-quarters and it was only on 19 September 1901 that a solitary individual was taken near Nerpalach Bay, Kotelny Island, the place of the "Sarja's" second wintering. During his sojourn in 1902 on the Island of New Siberia, Birula did not observe the species but the auxiliary expedition of

O. Cionglinski secured an adult male in nuptial plumage 1 June 1907 at Camp Stepanow on Faddejefski Island (specimen in collection). Finally Dr. Arnhold of the transport "Vaigach" of the Hydrographic Expedition to the Arctic Ocean found this bird on Wassiljefski Island.

On the Murman coast (Sect. III) the appearance of the Ruff was noted by Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) at Yeretiki, 10 June 1884, 31 May 1899 and 25 May 1900; and at Alexandrovsk 29 May 1901. On the Taimyr River (Sect. XII) in north latitude 73° 45′, Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 218, 1853) recorded its arrival 15 June 1843.

Data as to the different periods in the breeding of this bird are but few; on the Kanin peninsula (Sect. IV) Zitkow (Mem. Russ. Geogr. Soc., vol. 41, p. 124, 1904 (in Russian)) found on 27 July young birds already flying well and Pearson (Ibis, 1898, p. 202) found young in down at Habarova (Sect. X) on the same date in 1897. In Middendorff Bay, Western Taimyr (Sect. XII), Birula (1907) observed the last Ruff in 1900 on 14 September. In 1914 the Ruffs left the vicinity of Golchiha, in the mouth of the Yenisei (Sect. XI), as early as 27 August on account of a violent gale (Haviland, Ibis, 1915, p. 397).

Tryngites subruficollis (Vieillot).—The Buff-breasted Sandpiper was noted in August in considerable numbers ("quite common") by Nelson (Cruise of the Corwin, p. 90, 1883) in the vicinity of Cape Vankarema, on the north coast of the Chuckche peninsula (Sect. XXI).

Note.—In Professor Palmén's work (Sibir. Ishk. Fogelf., pl. 3, 1887), *Ereunetes pusillus* (Linné) is introduced (with a query) into the fauna of the north coast of the Chuckche peninsula (Sect. XXI). But although the "Vega" Expedition as well as Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, 1914), Gribanovski (Bull. Yakutsk Sect. Russ. Geogr. Soc., vol. 1, p. 116, 1915, in Russian) and Amory (Riley, Proc. U. S. Nat. Mus., vol. 54, 1918) did not find this species at all in those regions, and Nelson (Cruise of the Corwin, p. 88, 1883) states that it is a "common summer resident on the coast of north eastern Asia and Saint Lawrence Island, Bering Sea," I have not succeeded in finding any evidence that it inhabits the north coast of the Chuckche peninsula, so that I feel constrained therefore to strike this species from the list of birds inhabiting Section XXI.

35. **Calidris arenaria** (Linné) (=**Crocethia alba** (Pallas)).

(Plate 34; Plate 35, figs. 7–12).

Calidris arenaria (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 155, 1902. Birula, Bull. Acad. Sci. St. Pétersbourg, vol. 18, no. 3, p. 94, 1903. Brusneff, *ibid.*, vol. 20, no. 5, p. 181, 1904. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 4, 6–8, 11–18, 66–67, 94, 1907. Toll, Die russ. Polarf. d. "Sarja," p. 87, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: west coast of Taimyr Strait (Dr. H. Walter): adult female, 10 June 1901; adult female, 11 June 1901; adult female, 8 July 1901; adult male, 11 July 1901; adult female, 16 July 1901; adult male and three young, 29 July 1901; two young males, 27 August 1900; adult female, 4 July 1902, Bielkovski Island, New Siberian archipelago (Dr. V. Katin-Jartzeff); adult and four young (Plate 34, fig. 1),

23 July 1902, two young, 8 August 1902, adult female, 10 June 1902, immature, 5 August 1902 (Plate 34, fig. 2), all from Island of New Siberia (A. Birula); immature, 27 August 1901, Camp Michailow, Kotelny Island (O. Gionglinski); immature male and female, 1903, Island of New Siberia (M. Brusneff); adult and young, 15 July 1903, Camp Birula, Island of New Siberia; female, 1903, same data (M. Brusneff).

Eggs: four, 8 July 1901; four, 8 July 1901; three, 11 July 1901; four, 16 July 1901, all from west coast of Taimyr Strait (Dr. H. Walter); four, 23 June 1903, Camp Yegorow, Kotelny Island (P. Olenin); four, 29 June 1903, one (of three), 29 June 1903, both from Derewjannyja Mountains, Island of New Siberia (M. Brusneff); one (of two), 4 July 1902, Bielkovski Island, New Siberian archipelago (Lieut. Th. Matiessen's expedition; Dr. V. Katin-Jartzeff).

The Sanderling is a very characteristic bird of those portions of the Eurasian tundra explored by the Russian Polar Expedition. It cannot be regarded as a circumpolar species since it has not hitherto been found on those coasts of the Siberian Arctic Ocean from beyond the mouth of the Lena to Cape Deshneff. It inhabits Arctic America in considerable abundance, where in the vicinity of Franklin Bay the first eggs were procured in 1863,[1] and it nests commonly in Greenland.

In the palaearctic region it has been found by various explorers in Spitzbergen (Sect. I) (König, Avif. Spitzb., p. 169, 1911) and latterly in 1906, by Dr. Bruce as casually breeding in Prince Charles Foreland. The Oxford Expedition of the year 1921 obtained two males 3 July 1921 on the Reindeer peninsula of Liefde Bay and observed some others (Jourdain, Ibis, 1922, p. 171). In the same place the Merton College Expedition of the year 1923 succeeded in obtaining, 23 July 1923, one female and a clutch of four eggs (Langstaff, Ibis, 1924, p. 485) and Montague (Ibis, 1926, p. 142) a nest with four eggs; he also saw a dozen birds (11–12 July). On the Murman coast (Sect. III) the Sanderling is a rather rare migrant only and Goebel's supposition (Ornith. Jahrb., vol. 13, p. 114–115, 1902) that the birds he observed 27 June at Zip Navolok were nesting, does not seem to me sufficiently convincing. Although the Sanderling has not been recorded from the Kanin peninsula (Sect. IV), I have no doubt that it occurs there on migration, as well as on Kolguev (Sect. V) and Vaigach Islands (Sect. VII); while on the island of Nova Zembla (Sect. VIII, a) a single bird was seen by Buturlin (Our Hunting, pt. 8, p. 54, 1908; The Wading-birds of the Russian Empire, p. 245, 1906, in Russian) and two young birds were obtained on Matochkin-shar 3 September 1902 by Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 67). Gorbunow (*in litt.*) considers the Sanderling a rare bird at Nova Zembla, but observed it four times: 6 September 1923 at the Puchowaja Bay, 24 August 1924 at Cape Dmitrijeff, 5 August 1925 at the Belushja (Dauphin) Bay (South Island) and 8 September 1925 a flock in the Krasheninnikow Bay (North Island). It is found also in the latitudes of the mouth of the Pechora (Sect. VI), in the Yamal peninsula and at the mouth of the Ob (Sect. X) and of the Yenisei (Sect. XI). But it may also nest at

[1] These are the first eggs provided that one regards those figured by Thienemann (Fortpflanzung Vög., p. 62, fig. 2, a, c, 1848) as not belonging to the Sanderling.

times throughout all the sections mentioned, chiefly in the two last. In the Franz Josef archipelago (Sect. IX) Dr. Neale (Jackson, A Thousand Days in the Arctic, vol. 2, p. 402, 1899) claims to have seen the Sanderling at Cape Flora. The region in which it nests in considerable abundance lies along the shores of the Siberian Arctic Ocean from Taimyr (Western—Sect. XII—and Eastern—Sec. XIII) to the latitudes of the mouth of the Lena (Sect. XIV) and to the islands of the New Siberian archipelago (Sect. XVI). In the collection of our Zoölogical Museum I found a Sanderling's egg coming from the mouth of the Lena, where it was collected by Dr. Bunge and identified as that of *Arenaria interpres* (Linné). Eastward along the Siberian coast the Sanderling has not hitherto been noted although it must occur there during its periodic migrations for it has been recorded on passage in different parts of the east coast of Asia. I should mention here that the Sanderling, during its nesting season, very probably occupies still another region quite isolated from its northern breeding grounds, notably the salt seas of the Aralo-Caspian desert. Up to the present time no one has found either eggs or young of the Sanderling there, but a number of Russian ornithologists, among them Professor Sushkin, have found it in that region in summer and from the birds' actions admit the possibility of its nesting in these countries. For myself, I am inclined also to admit this possibility, because I have had occasion in two consecutive years (1872 and 1873) to note the appearance of young Sanderlings in the first half of August along the Ural River in the vicinity of Orenburg. Obviously these young birds could not have come from the distant breeding grounds of northern Siberia and must have been reared in some place nearer at hand where the parent birds must have commenced to nest earlier so that the young birds had already learned to fly about the beginning of August. This very curious and interesting circumstance is evidence that the two great salt seas of the Aralo-Caspian region extended farther to the northward in the long-distant past and were united with the Siberian Arctic Ocean. The Sanderling, probably in common with some other species of shorebirds, such as *Ancylochilus subarquatus* (Güldenstädt), inhabited then the shores of this great basin of salt water from the Aralo-Caspian countries on the south to Taimyr on the north; and after the division of this basin into two separate seas a colony of them remained in the Aralo-Caspian region where it has continued to breed.

The Russian Polar Expedition on 11 September 1900, met with the Sanderling in limited numbers on migration in Middendorff Bay, Western Taimyr (Sect. XII) (Birula, 1907; Toll, 1909). In 1901, this species was discovered nesting abundantly in the vicinity of the "Sarja's" first winter-quarters and Dr. Walter (1902) succeeded in procuring four sets of eggs and a brood of young. During the Expedition's stay in the New Siberian archipelago the Sanderling was noted on Bielkovski Island (Lieutenant Th. Matiessen's expedition), on Kotelny Island (auxiliary expedition of O. Cionglinski

in 1901 and of P. Olenin in 1903; Naval Lieutenant A. Kolchak, 1903, *in litt.*) and on the Island of New Siberia (Birula, 1903, 1907; Brusneff, 1904) where it was nesting everywhere; it was observed also on Faddejefski Island in considerable numbers on 30 August 1881 by Newcomb, naturalist of the "Jeanette" (Nelson, Cruise of the Corwin, p. 89, 1883).

Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) notes the time of arrival of the Sanderling in high latitudes on 25 May 1900 at Yeretiki Bay, Murman coast (Sect. III). In 1901 this bird arrived in Western Taimyr (Sect. XII) on 10 June (Dr. Walter, 1902, *et in litt.*) and was first observed by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 219, 1853) on the Taimyr River, latitude 74° north, 16 June 1843. Birula (1904, 1907) recorded its appearance on the Island of New Siberia on 5 June 1902.

Dr. Walter (1902) who succeeded in obtaining four sets of eggs and some young of the Sanderling at the "Sarja's" first wintering place in Western Taimyr, gives the following account of the breeding habits of this bird:

> The male mounts on quivering wings some ten feet above the ground, uttering a short strident cry recalling the syllables *trrr-trrr-trrr*, and returns to the ground. Of the four nests found on 8, 11, and 16 July 1901, three contained four eggs each, the fourth three eggs, slightly incubated. In contrast to the habit of other shorebirds that place their nests usually in those parts of the tundra covered with herbage, the Sanderling makes its nest on the moss among the lumps of clay. The nest is but a slight depression, round and shallow, lined with a few blades of grass and bits of white lichen. In two cases it was the male, and in the two other cases the female that was brooding the eggs. It is thus evident that the two sexes share the duties of incubation. The young birds found on 29 July, were attended by the male who showed great solicitude for his progeny, while the female did not appear. Even during the nesting period a portion of the Sanderlings already lead a nomadic life in little flocks.

On the Island of New Siberia, Birula (1907) found the Sanderling breeding in abundance and describes its behavior during the nesting season in the following terms:

> *Calidris arenaria* was the first shorebird observed in the spring of 1902 on the Island of New Siberia. On 5 June, with a moderate east-southeast wind and a noon temperature of +1.4° Centigrade, I saw three Sanderlings headed northward. After this date I find in my journal almost daily notes of this bird as the commonest inhabitant of the tundra. On 8 June I noticed the characteristic evolutions of the male, paying court to his mate; one of the Sanderlings attracted my attention by his short flights from one spot bare of snow to another. He would mount into the air to a height of not more than seven to ten feet and with rapidly vibrating wings, give vent to his low courtship note. After such a performance he would alight on the tundra, run back and forth, peck at the moss and again begin his aërial evolutions. At first after their arrival on the Island of New Siberia, I saw only single birds or more often pairs; however, all my efforts to find a nest of this Sandpiper were fruitless, for the birds always left their nest long before I was near, and remained quite undisturbed without any show of alarm that might have shown me that the nest was near at hand. In the same way the bird only returned to its nest after a long time, which made observations on the cold, damp tundra very difficult, so that one was constrained to leave the place without obtaining any positive result. It was only once, on 19 July, that a Sanderling made any serious attempt to draw my attention from its nest, going through the same performances as *Tringa canutus*, that is, puffing out its plumage, dragging itself along the ground, and giving utterance to its cries. Clearly it was trying to draw me away from its nest, which

contained eggs, already incubated though I was unable to discover it. *Calidris arenaria* must be considered as a very silent Sandpiper. Beyond its courtship rattle, and a short alarm-note, like *pit-pit*, I have heard no other sound given by it. During its nesting season the Sanderling does not avoid the neighborhood of other birds. In the early part of July rather numerous companies of this species appear, leading a nomadic life on the tundra, until their departure in the autumn. Such flocks of Sanderlings all summer long delight to frequent the seashores where they keep in muddy places left bare by the tide. In the summer season I have seen only Sanderlings in such places and no other species of shorebirds, but in autumn when the tundra becomes frozen, such sandy beaches by the sea-borders become the gathering places of all sorts of Sandpipers that inhabit the tundra of New Siberia. It was not until 23 July that I succeeded in securing an entire brood of very small young-in-down of *Calidris arenaria*. The old bird with its young was in a dry spot covered with clumps of vegetation on a gentle slope, which prevented it from seeing me until I had approached within thirty paces. It immediately started to run erecting its feathers and uttering whistling notes, while the four young birds instantly hid among the clumps in different directions. I soon succeeded in finding three of the young, but the fourth escaped my sight for a long while, although it was crouched among the variegated clumps of lichens not more than three paces distant. On 3 August I secured another young Sanderling the wing quills of which were beginning to appear; the male parent alone was with it. On 8 August young birds already strong on the wing were seen and taken. Almost at the same time, flocks of young Sanderlings, most of them still retaining down on their heads, appeared in increasing numbers on the sandy beaches of the seashore. I have observed on the Island of New Siberia, as well as in Taimyr, that in contrast to the other shorebirds, the parent Sanderlings desert their young as soon as the latter are able to fly. As a result one may observe, toward the end of the breeding season of this bird, young Sanderlings in broods of four unaccompanied by their parents, near little streams and water pools. These young birds still retain a considerable amount of down on their heads. They are exceedingly unsuspicious at these times. By avoiding sudden movements, one may approach them very closely, to within five to ten feet, and observe these dainty birds as they gather small gnats and *Poduridae*, keeping by the water's edge. Gradually the various broods of young Sanderlings unite into flocks and for a certain time lead a wandering existence on the tundra, not going far, however, from the seashore, which they regularly frequent during the hours of ebb tide to seek food on the bare sand beaches. By this time the flocks of adult Sanderlings have already left the island and when the first light frosts heralded the approach of winter I saw on 13 and 14 August, among the numerous flocks of *Crymophilus fulicarius* that haunted the sand beach opposite my quarters, the last flocks of Sanderlings which were then leaving all our island. On 20 and 24 August I noticed solitary individuals of this species in the tundra and on 5 September I recorded the last two among the numerous flocks of *Crymophilus fulicarius*.

The eggs of the Sanderling, very rare in oölogical collections, show the following variations in color, dimensions and weights:

1. Four eggs, 8 July 1901, west shore of Taimyr Strait (Dr. Walter).—The ground color of this set of eggs is a deep olive buff (Ridgway, ed. 2, 1912, Pl. 40); the superficial spots, especially the larger ones, are arranged concentrically about the obtuse end; at the pointed end they are either small dots or fine points while the large spots are very few in number. The eggs of this set show the following dimensions and weights: 33 mm. x 24.5 (48 cg.); 36.1 x 25.5 (54 cg.) (Pl. 35, fig. 11); 34.1 x 26 (57 cg.); 34 x 26.1 (49 cg.).

2. Four eggs, 8 July 1901, west shore of Taimyr Strait (Dr. Walter).—The ground color is likewise deep olive buff (Ridgway, 1912, Pl. 40), the spots of an olive brown (*ibid.*, Pl. 40). The spots in this set are smaller and finer than those in the first set. Dimen-

sions and weights: 36.6 mm. x 24.3 (53 cg.); 32.8 x 24.8 (50 cg.) (Pl. 35, fig. 7); 34.1 x 24.9 (53 cg.); 35.8 x 25 (55 cg.).

3. Three eggs, 11 July 1901, west shore of Taimyr Strait (Dr. Walter).—The tints of coloration are quite like those of the last set, but since the eggs of this set are much less spotted and since the small spots especially are lacking, the ground color is more striking in appearance and the eggs seem to be brighter. Dimensions and weights: 38 mm. x 24.7 (58 cg.); 36.9 x 24.1 (51 cg.) (Pl. 35, fig. 12); 37.5 x 24.7 (52 cg.).

4. Four eggs, 16 July 1901, west shore of Taimyr Strait (Dr. Walter).—The eggs of this set are of a slightly more greenish tint than deep olive buff (Ridgway, 1912, Pl. 40) but are brighter than citrine drab (*ibid.*); the spots are of an olive brown (*ibid.*). Dimensions and weights: 37.5 mm. x 25.2 (56 cg.) (Pl. 35, fig. 9); 37.6 x 25.1 (51 cg.); 36.1 x 25 (56 cg.); 37 x 24.7 (52 cg.).

5. Four eggs, 23 June 1903, Camp Yegorow, Kotelny Island (P. Olenin).—The eggs of this set are brighter and their ground color approaches olive buff (Ridgway, 1912, Pl. 40); the light spots are large and numerous, their tint is of an olive brown (*ibid.*), in some more reddish, approaching natal brown (*ibid.*). Dimensions: 35 mm. x 26; 35.7 x 26.2; 36 x 25.7; 36.1 x 26.

6. Four eggs, 29 June 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff).—The color of the eggs of this set is likewise olive buff (Ridgway, 1912, Pl. 40), but of a greener tint. The spots have a grayer tint, approaching grayish olive (*ibid.*, Pl. 46). Dimensions and weights: 35 mm. x 26 (64 cg.); 35 x 26; 35.7 x 26 (60 cg.) (Pl. 35, fig. 10); 35.6 x 26 (59 cg.).

7. One egg (of three), 29 June 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff) (Pl. 35, fig. 8): no measurements.

8. One egg (of two), 4 July 1902, Bielkovski Island, New Siberian Archipelago (Dr. Katin-Jartzeff).—Dimensions and weight: 36.2 mm. x 25.1 (55 cg.).

The plate of the young of the Sanderling (Plate 34), painted by our distinguished artist, W. Watagin, of Moscow, shows one young in down and a second half-fledged. A careful examination of eight downy young brought back by the Russian Polar Expedition convinces me that there is a certain difference in the coloration of newly-hatched young and those that are beginning to obtain their contour feathers. In the very small chicks the throat and fore neck are of a pinkish buff (Ridgway, 1912, Pl. 29); the ground color of the front and sides of the head and the fore part of the eyebrow is of a darker tint, approaching "pale pinkish cinnamon" (*ibid.*, Pl. 29). The superciliary line from the eye to nape is of a mikado brown (*ibid.*, Pl. 29). The anterior extremities, the flanks, and the lower part of the back are "tawny olive" (*ibid.*, Pl. 29). The entire upper parts are covered with spots and dull black streaks which predominate over the

ground color, especially on the back. Finally, on the occiput and back the down is tipped with "pale olive buff" (*ibid.*, Pl. 40). These bright spots are close together and give the upper parts a much-speckled appearance, The breast and belly are covered with a down that is almost white, very faintly washed on the flanks with the same pinkish buff as the fore part of the neck. The bill and feet, when dried, appear black.

The young, when nearly half the adult size, begin to feather out and may be distinguished from the newly hatched young by the tints of the down being much less bright, as if faded. The throat is nearly white and has lost most of its pinkish buff color (*ibid.*, Pl. 29), and the forehead, front and cheeks are become brighter. Above, the tawny-olive color predominates while the black speckles are become less marked; finally the bright tips of the down have largely disappeared, and those that remain are smaller, less obvious and much less dark. On breast and belly the white down has become more transparent, allowing its grayish bases to appear indistinctly.

The eggs of the four sets found by Dr. Walter (1902, *et in litt.*) in Western Taimyr between 8 and 16 July 1901, were slightly incubated, and those taken by Brusneff on the Island of New Siberia, 29 June 1903, were more heavily incubated. Newly hatched young have been recorded at the mouth of the Lena 27 July by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 136, 1887) and by Birula (1904, 1907) on the Island of New Siberia 23 July 1902; while the young which Dr. Walter procured 29 July 1901 in Western Taimyr, and those taken by Brusneff 15 July 1903 on the Island of New Siberia, were probably a week old for they were already beginning to feather out. The half-downy young shown in our plate (Pl. 34) was taken by Birula on the Island of New Siberia, 3 August 1902.

In the translations from the notebooks of Walter and Birula I have already given their observations on the nomadic life of the young Sanderlings before their departure from high latitudes and have added the precise dates of the departure of the species from the Island of New Siberia in 1902. I have only to add that according to Dr. Walter the Sanderlings left Western Taimyr in 1901 about the second week of September.

Eurynorhynchus pygmaeus (Linné).—*Local name:* in Chukche, *uljpatschak* (Palmén). During the voyage of the "Vega," this species appeared in very large numbers, 19 June 1879, in the neighborhood of the vessel's winter-quarters on the north coast of the Chukche peninsula (Sect. XXI) (Palmén, Sibir. Ishk. Fogelf., p. 326, 1887). They remained only eight days and after 28 June were not seen again the rest of the summer. Personally I think, and indeed am almost convinced, that this bird breeds in that country and that the honor of the discovery of its eggs belongs to the "Vega" Expedition. I base this opinion on the fact that the set of three eggs (No. 472; *ibid.*, p. 323) found 3 July 1879 at the winter-quarters and attributed by Meves to *Heteropygia acuminata* (Horsfield) really belongs to *Eurynorhynchus pygmæus* (Linné). I quite agree with Buturlin (The Waders of Russian Empire, pp. 95, 98, 1906 (in Russian)) that these eggs could not possibly belong to *Heteropygia acuminata*, a bird which is almost of the same size as *Heteropygia maculata* (Vieillot) and obviously should have eggs of dimensions

approaching those of the latter species, which according to Murdoch (Rept. Internat. Pol. Exp. Pt. Barrow, p. 112, 1885) measure: 40.1 mm. x 26.9; 39.1 x 25; 36.6 x 28.2; 36.1 x 27.3, while the eggs of the set in question measure only: 32 mm. x 23; 33 x 22.8 and 31.5 x 23.3. Aside from that, I have no doubt that this set would have been recognized at once by so experienced an oölogist as the late W. Meves, who identified it, had it belonged to some European species or to some eastern form of a similar species. I am quite convinced that we have to do here with the eggs of a species that nests only in the extreme east of the Eurasian tundra and the eggs of which are unknown or imperfectly so. Finally, I find that the description and measurements of authentic eggs of *Eurynorhynchus pygmaeus* (Linné) taken by Captain F. Kleinschmidt near Cape Serdze-Kamen show no important differences from the eggs brought back by the "Vega." A careful comparison of Meves' description with the description and figure given by Thayer (Auk, vol. 28, p. 153–155, 1911) has almost convinced me of the absence of any important difference in color between the two sets, while the measurements given below are also in perfect agreement with each other:

Measurements of the eggs taken by the "Vega."	*Measurements of the eggs taken by Kleinschmidt.*
a. 32 mm. x 23	a. 31 mm. x 24
b. 33 mm. x 22.8	b. 31.2 mm. x 23
c. 31.5 mm. x 23.3	c. 31 mm. x 22.7
	d. 33.1 mm. x 23

I have therefore no hesitation in identifying the set of eggs found by the "Vega" Expedition, 3 July 1879, at that vessel's winter-quarters, as belonging to the Spoon-billed Sandpiper (*Eurynorhynchus pygmaeus* (Linné)) and in attributing to Professor Nordenskiöld's expedition the honor of being the first to find the eggs of this remarkable and peculiar Sandpiper. Independently of this expedition, the species was several times noted between the "Vega's" wintering place and Cape Deshneff in 1881 by Nelson (Cruise of the Corwin, p. 87, 1883). Again, 15 July 1910, Captain Kleinschmidt (Thayer, 1911; Buturlin, Mess. Ornith., 1911, p. 112; 1912, p. 54–56) succeeded in finding near Cape Serdze-Kamen (67° 3′ north latitude, 8° 30′ east longitude) a nest of this Sandpiper containing four eggs very heavily incubated, as well as eight young of different broods. Lastly, Dixon (Auk, vol. 35, p. 387–404, 1918) reports the finding of young birds (still unable to fly), 24 July 1909, on Koljuchin Island and on 29 July 1909 near Cape Vankarema.

36. Heteropygia (= Calidris) maculata (Vieillot).

Heteropygia maculata (Vieillot). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901.
Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 67, 69, 1907.
Tringa maculata (Vieillot). Toll, Die russ. Polarf. d. "Sarja," p. 68, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: female, 24 August 1900, Western Taimyr (Dr. H. Walter; obtained by Birula); female, 22 June 1902, Elijdep promontory, Charaulach Mts., mouth of the Lena (M. Brusneff).
Eggs: two, 11 July 1902, mouth of the Charaulach River, Lena system (M. Brusneff).

Local name: in Yakut, *oghut* (Bunge, sub *Tringa maritima*).

On 24 August 1900 Birula (Walter, 1901, *et in litt.;* Birula, 1907; Toll, 1909) succeeded in shooting a female *Heteropygia maculata* (Vieillot) that was in company with four others, at Minin Bay, Western Taimyr (Sect. XII). An individual of this species was found by the "Vega" Expedition, 20 August 1878, at Cape Cheljuskin (Sect. XIII) (Palmén, Sibir. Ishk. Fogelf., p. 321, 1887). Again, Dr. Bunge records this bird in the

latitudes of the mouth of the Lena (Sect. XIV) but he identified it as either *Tringa maritima* or *Tringa alpina*. In the accounts of his stay at the mouth of the Lena he lists *Tringa maritima* (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 125, 1887) and makes no mention of *Heteropygia maculata* (Vieillot). But I have been able to find among the collections of our Zoölogical Museum only a single egg probably belonging to a representative of the genus *Arquatella*, brought back by Dr. Bunge, while I did find two specimens of *Heteropygia maculata* (Vieillot), one of which was taken in August at Mostach and the other in 1884 at Sagastyr (the latter identified as *Tringa alpina*), and I feel quite certain that his observations on *Tringa maritima* refer to *Heteropygia maculata* (Vieillot). In the same region, Brusneff secured a female, 14 June 1902, on the Elijdep promontory, in the Charaulach Mountains, and on 11 July 1902, a set of two eggs heavily incubated. This species has also been found in the New Siberian archipelago and our Zoölogical Museum has two females taken 20 June 1886 on Kotelny Island by the late Baron Toll. In the latitudes of the mouth of the Kolyma (Sect. XIX) according to Buturlin (Ibis, 1906, p. 133; 1907, p. 571–573) it nests abundantly; Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 15–16, 1914) met with this species at the mouth of the river Medweshja. Nelson states that a pair was seen, 18 August 1880, to the northwest of Wrangel Island (Sect. XX) in 76° north latitude by Newcomb, naturalist of the "Jeanette," and he himself (Cruise of the Corwin, p. 86, 1883) noted this bird in 1881 as a summer resident in various places on the north coast of the Chuckche peninsula (Sect. XXI). At Koljuchin Bay, Amory (Riley, Proc. U. S. Nat. Mus., vol. 54, p. 613, 1918) secured an immature female 10 August 1914.

Buturlin and Koren are the only persons who have had an opportunity to study the periodic events in the life of this Sandpiper and give us the following data. According to Buturlin the first birds appeared at Cape Baranow (east of the mouth of the Kolyma) on 11 June 1905; they had young in the third week of July; the first young bird able to fly was found 4 August. By the middle of September the young birds were migrating past the mouth of the Kolyma; this passage lasted until 22 September and the last birds were seen at Pochodskoje on 3 October. Koren (1914) secured a female with two newly hatched chicks 5 July near the mouth of the river Medweshja, Kolyma delta, and observed young birds able to fly 30 July 1912 at Chaun Bay, Chuckche peninsula.

The nest of *Heteropygia maculata* (Vieillot) found 11 July 1902 by Brusneff at the mouth of the Charaulach River was situated in a marshy place and consisted of a hollow in a tuft of moss. It contained two well-incubated eggs. These eggs in shape approach those of the *Scolopacinae* rather than those of the *Tringinae*. The ground color is an olivaceous buff, darker than the deep olive buff of Plate 40 of Ridgway's Nomenclature of Colors (1912), and brighter than the dark olive buff of the same plate. A very few of

the smaller spots of the ground color are of an olive brown (*ibid.*, Pl. 40) and the broader superficial spots, grouped chiefly about the large end where they form a sort of wreath, are of a blackish brown (*ibid.*, blackish brown No. 2, Pl. 45). The eggs measure as follows: 41 mm. x 28.8; 42.1 x 28.7.

Heteropygia(=Calidris) acuminata (Horsfield).—Buturlin (Journ. f. Ornith, vol. 56, p. 293, 1908) records this species as a migrant at the mouth of the Lena (Sect. XIV), probably nesting in the valleys of the Alazeja and the Indigirka (Sect. XVIII), and as a bird of passage at the mouth of the Kolyma (Sect. XIX) (Dresser, Eggs Birds of Europe, p. 821, 1910), where it was obtained also by Copley Amory (Riley, Proc. U. S. Nat. Mus., vol. 54, p. 613, 1918).

The three eggs brought from these same regions by the "Vega" Expedition and by W. Meves attributed (Palmén, Sibir. Ishk. Fogelf., p. 323, 1887) to this species, cannot in reality belong to it as Buturlin has already shown (The Waders of the Russ. Empire, pp. 95, 98–99, 176, 1906 (in Russian); Dresser, 1910, pp. 691, 821); neither do they belong to *Limicola sibirica* Dresser nor to *Tringa bairdi* Coues as Buturlin supposes, but very probably to *Eurynorhynchus pygmaeus* (Linné). The reasons in detail on which this view is based are given in the article on this latter species.

NOTE.—I have been unable to see why Professor Palmén (Sibir. Ishafsk. Fogelf., Pl. 4, 1887) and Schalow (Fauna der Arktis, p. 195, 1905) introduce *Heteropygia bairdii* (Coues) into the fauna of the north coast of the Chuckche peninsula. Nelson (Cruise of the Corwin, p. 88, 1883) cites but a single example from the Siberian coasts, found in St. Lawrence Bay on the east coast of the Chuckche peninsula and I have not succeeded in finding any other data as to the occurrence of the species in the countries here considered.

Heteropygia(=Calidris) fuscicollis (Vieillot).—A female of this American species was killed 28 June at Cape Flora, in the Franz Josef archipelago (Sect. IX) by Wilton, a member of the Jackson-Harmsworth Expedition (Jackson, A Thousand Days in the Arctic, vol. 2, p. 401, 1899). Clearly this is an altogether exceptional case of the occurrence of an individual that probably joined a flock of other shorebirds, perhaps *Arquatella maritima maritima* (Brünnich) and reached these high latitudes with them.

37. Limonites(=Calidris) minuta minuta (Leisler).

Limonites minuta (Leisler). WALTER, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 236, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 156, 1902. BIRULA, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 2, 5–8, 67, 68, 1907.
Tringa minuta. TOLL, Die russ. Polarf. d. "Sarja," p. 68, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: two immature, 14 August 1900, Diekson Bay, mouth of the Yenisei (Dr. H. Walter); immature female, 24 August 1900, Western Taimyr (Dr. H. Walter); adult male, 2 July 1901, adult male, 6 July 1901, adult female, 9 July 1901, adult female and four young, 29 July 1901, all from west shore of Taimyr Strait (Dr. H. Walter); adult female, May 1902, adult, 8 June 1902, adult male, 8 June 1902, all from Charaulach Mountains, Elijdep promontory, mouth of the Lena (M. Brusneff); adult, 28 October 1903, mouth of the Lena (Th. Matiessen).
In alcohol: young in down and three eggs, 8 July 1901, west coast of Taimyr Strait (A. Birula).
Eggs: four, 2 July 1901, three, 9 July 1901, west coast of Taimyr Strait (Dr. H. Walter); two, May 1902, Elijdep promotory, Charaulach Mts., mouth of the Lena (M. Brusneff).

The Little Stint nests in the Eurasian tundra region from the Murman coast (Sect. III) to the mouth of the Indigirka (Sect. XVIII) whence Buturlin (Dresser, Eggs Birds of

Europe, p. 697, 1910) procured it. It has been recorded from Kolguev Island (Sect. V), Vaigach Island (Sect. VII), the south island of Nova Zembla (Sect. VIIIa), and was found by the Russian Polar Expedition in most of the islands of the New Siberian archipelago. We lack information as to its occurrence in the Kanin peninsula (Sect. IV) and at the mouth of the Yana (Sect. XV). I have carefully examined all the specimens of Stints in our Zoölogical Museum coming from the Siberian tundra and have assured myself that all the specimens collected by the Russian Polar Expedition in Western Taimyr and the Charaulach Mountains, at the mouth of the Lena, those collected in Taimyr by Middendorff, those from 76° 40′ north latitude, 100° 58′ east longitude taken by Dr. Starokadomski, surgeon of the transport "Taimyr" of the Hydrographic Expedition to the Arctic Ocean, as well as those from Great Ljakoff Island taken by Dr. Bunge, are all perfectly typical *Limonites minuta minuta* (Leisler). Also, Dr. Bunge in 1883 collected a typical female at Sagastyr, mouth of the Lena, and in 1884 in the same region an adult male of *Limonites minuta ruficollis* (Pallas). Buturlin was, therefore, quite mistaken in informing Dresser (Ibis, 1908, p. 489) that the latter form is the only Stint nesting in the vicinity of Sagastyr, mouth of the Lena. Taking into account the fact that Brusneff, of the Russian Polar Expedition, found only the typical form of Least Sandpiper nesting in the Charaulach Mountains, I am inclined to suppose that: (1) the undoubted example of *Limonites minuta ruficollis* (Pallas) secured by Dr. Bunge, should be regarded as an accidental visitor in the mouth of the Lena; (2) *Limonites minuta minuta* predominates there; and (3) all Dr. Bunge's notes on its nesting habits made at the mouth of the Lena, and at Great Ljakoff Island relate exclusively to the western form. Dr. Bunge brought back from the mouth of the Lena in all fourteen eggs of this species, one set of which, taken 6 July 1883, goes with the female No. 33, an undoubted *Limonites minuta minuta* (Leisler). I have carefully verified and checked these facts.

The Russian Polar Expedition first met with the Little Stint 7 August 1900 on Vaigach Island (Sect. VII), next on 14 August 1900 in Dickson Bay (Sect. XI), then in Minin and Middendorff Bays of Western Taimyr (Sect. XII) (Walter, 1901, *et in litt.*; Birula, 1907; Toll, 1909). In 1901 this bird appeared in the vicinity of the "Sarja's" winter-quarters 14 June (Walter, *in litt.*) and nested there in notable abundance. It was next observed by M. Brusneff (*in litt.*) breeding in the Elijdep promontory in the Charaulach Mountains (Sect. XIV). In the New Siberian archipelago the Russian Polar Expedition found the Least Sandpiper on almost every island of the archipelago, but omitted to bring any specimens from these islands. In addition to the statements of Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 276 *et seq.*, 1887) as to Great Ljakoff Island according to which this bird nests abundantly there, Naval Lieutenant A. Kolchak (*in litt.*) found it 31 May 1903 on Little Ljakoff Island, and Naval Lieutenant

Th. Matiessen (*in litt.*) found it nesting on Bielkovski Island. Kolchak tells us that in the summer of 1902 it was very common in the vicinity of Nerpalach, Kotelny Island, and that in 1903 he noted it in moderate numbers nesting near Camp Michailow and saw it also at Balyktach. In 1902 Birula (1907) did not meet with the Little Stint on the Island of New Siberia but in 1903, Brusneff (*in litt.*) succeeded in finding on 4 July a nest and eggs on that island.

The arrival of the Little Stint in high latitudes has been noted by Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) at Alexandrovsk (Sect. III) 3 June 1901; by Schaanning (Dansk. Ornith. For. Tidskr., vol. 10, pp. 150, 158, 1916) at Matochkin-shar, Nova Zembla (Sect. VIII) 19 June 1903; by Dr. Walter (*in litt.*) in Western Taimyr (Sect. XII) 14 June 1901; and by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 221, 1853) 29 June on the Taimyr River, under 74° north latitude (Sect. XII). On 31 May 1903, Kolchak (*in litt.*) observed a single bird on Little Ljakoff Island and found it on the tundra of Kotelny Island between 3 and 8 June 1902 and on 5 June 1903.

In regard to the time of egg-laying, we have the following notes: Buturlin (The Waders of the Russ. Emp., p. 141–142, 1906) found fresh eggs on Kolguev Island (Sect. V) between 4–6 July and 15 July; on 7 and 16 July the eggs were incubated, 19–21 July they were ready to hatch and toward the second week of July one might also find young in down. In Nova Zembla (Sect. VIII) similar young were found in late July. At Matochkin-schar, Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 64) found in 1903, at least seventeen sets of eggs and three broods of young. He makes the following statements as to the laying of the first egg in each set: 25 June, one set; 30 June, one set; 2 July, three sets; 4 July, two sets; 5 July, one set; 7 July, seven sets; 11 July, one set; 13 July, one set. He noted the hatching of the first young on 24 July. Middendorff (1853) found eggs in Taimyr 13 July 1843; Dr. Bunge (1887) found fresh eggs on Great Ljakoff Island 30 June 1886, while Birula in Western Taimyr found heavily incubated eggs 5 July 1901. The three sets of eggs of this species brought back by the Russian Polar Expedition show no peculiarities of color and have the following measurements:

1. Four eggs, 2 July 1901, west coast of Taimyr Strait (Dr. Walter): 28 mm. x 20 (27 eg.); 27.5 x 19.6 (27 eg.); 27 x 19 (27 eg.); 27.1 x 20 (27 eg.).

2. Three eggs, 9 July 1901, same place and collector: 29 mm. x 20 (27 eg.); 28.6 x 21 (27 eg.); ——.

3. Two eggs, May 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff): 28.1 mm. x 20 (35 eg.); 30.1 x 19.1 (33 eg.).

Downy young have been found on the following dates: by Gorbunow (*in litt.*) at Nova Zembla (Sect. VIII) a young bird in down 3 August 1923; in Belushja; Bay in the Yamal peninsula (Sect. X) by Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 336,

1912) 11 July; by Dr. Walter (*in litt.*) in Western Taimyr (Sect. XII) on 29 June 1901 and by Middendorff (1853) 22 July 1843; by Dr. Bunge (1883, 1887) at Sagastyr, mouth of the Lena (Sect. XIV) 28 July and on Great Ljakoff Island (Sect. XVI) small chicks 29 July 1886, and large young in down 4 August 1886. Dr. Bunge saw young birds already able to fly in Borchaja Bay, mouth of the Lena, on 5 August and on Great Ljakoff Island, 13 August. According to Dr. Walter (*in litt.*) flocks of young Little Stints were seen in 1901, in Western Taimyr from 7 August. Finally the departure of this species from high latitudes took place at Matochkin-shar, Nova Zembla (Sect. VIII) before 10 August 1902 (Schaanning, 1916); at Golchiha, mouth of the Yenisei (Sect. XI) (Haviland, Ibis, 1915, p. 397) on 27 August 1914 and according to Middendorff (1853) from Taimyr (Sect. XII) on 23 August 1843.

Limonites (=Calidris) minuta ruficollis (Pallas).—I know of but four specimens of this bird from the Eurasian tundra zone: the first was taken in the Eastern Taimyr, in north latitude 76° 40′, east longitude 100° 58′, by the Hydrographic Expedition to the Arctic Ocean; the second was killed in 1884 at the mouth of the Lena (Sect. XIV) by Dr. Bunge (preserved in our Zoölogical Museum); while the two others were secured by members of the "Vega" Expedition at Jinretlen, north coast of the Chuckche peninsula (Sect. XXI), one on 20 June 1879 by Boström, the other on the following day by Johnsen. Perhaps it may also appear occasionally at the mouth of the Yana but it was not noted there except at Ustjansk (collection of our Zoölogical Museum), that is, outside the tundra region, where undoubtedly it is of only casual occurrence.

38. **Limonites (=Calidris) temminckii** (Leisler).

List of Specimens from the Russian Polar Expedition.

Eggs: two, 18 June 1902, Charaulach Mts., mouth of the Lena (M. Brusneff).

Temminck's Stint is found during the breeding season in the subalpine zone of northern Europe and Asia and only exceptionally appears in the lower parts of the alpine zone. For this reason, its breeding area lies farther to the south and does not reach such high latitudes as that of *Limonites minuta minuta*. It is altogether absent from the islands and archipelagoes of the Eurasian Arctic Ocean situated at a distance from the mainland, such as Spitzbergen, Bear Island, the Franz Josef archipelago, as well as from Nova Zembla, the New Siberian archipelago, De Long, Wrangel and Herald Islands. During its breeding season it inhabits probably the entire Eurasian arctic coast from the Murman coast (Sect. III) to the north coast of the Chuckche peninsula (Sect. XXI) but has not been certainly recorded from Eastern Taimyr (Sect. XIII) or the regions of the mouths of the Yana (Sect. XV) and the Indigirka Rivers (Sect. XVIII). It nests also in some abundance on Kolguev Island (Sect. V) and in small numbers on Vaigach Island (Sect. VII). Along the shores of the Arctic Ocean it appears only in places where the subalpine zone reaches the seacoasts or approaches them and it is therefore rarer and of

more sporadic distribution than *Limonites minuta minuta* (Leisler). At the mouth of the Yenisei (Sect. XI) Temminck's Stint has been found up to 72° north latitude and in Western Taimyr (Actinia Bay) as far north as 76° 15′ north latitude. The Russian Polar Expedition did not find this species either in Taimyr or in the New Siberian archipelago but Brusneff secured a set of two eggs in the Charaulach Mountains, region of the mouth of the Lena, that can belong to no other bird. Brusneff attributed these eggs to a *Pelidna alpina alpina* (Linné) that he shot in the same place 3 June 1902; but since the eggs cannot by any possibility belong to the latter species and were not obtained until 18 June 1902 there is obviously an error in his identification. I have carefully compared the two eggs with eggs of various *Tringae* and feel perfectly confident that they can belong to none other than *Limonites temminckii* (Leisler) and that they differ in no wise from the eggs of this species from various localities, preserved in our Zoölogical Museum. The ground color of these eggs is a pale olive buff (Ridgway, 1912, Pl. 40), the deeper spots of a light grayish olive (*ibid.*, Pl. 46) and the more superficial ones chiefly of a natal brown (*ibid.*, Pl. 40) and in places where the pigment is denser, of a darker brown (bone brown, Ridgway, Pl. 40). The eggs show the following dimensions and weights: 29 mm. x 21 (35 cg.); 30 x 21 (37 cg.).

The arrival of the Temminck's Stints on the Murman coast (Sect. III) was noted by Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) at Yeretiki on 25 May 1883, 31 May 1884, 17 June 1890, 1 June 1900; and at Alexandrovsk, 31 May 1901. Its time of departure from Golchiha, mouth of the Yenisei (Sect. XI) was recorded by Haviland (Ibis, 1915, p. 297) as 27 August 1914.

In the western parts of the Murman coast (Sect. III) and particularly in the region of the Pasvig River, Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130–131, 1903 (in Russian)) found sets of fresh eggs of this species between 9 and 20 June; and in the vicinity of the Rybachi peninsula (Zip Navolok, Yeretiki) and at Alexandrovsk incubated sets between 19 June and 12 July. In the eastern part of the same coast in the vicinity of the Lapp village Yokanskoje the eggs found by Pearson (Beyond Petsora Eastw., p. 317, 1899) 24 June 1895 were fresh. Downy young have been found in the Kanin peninsula (Sect. IV) by Zitkow (Mem. Russ. Geogr. Soc., vol. 41, p. 123, 1904) on 5 July and on Vaigach Island (Sect. VII) by Pearson (Ibis, 1898, p. 201) on 6 July.

39. Arquatella (=Calidris) maritima maritima (Brünnich).

Arquatella maritima (Gmelin). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 236, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 157, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 2, 4, 8, 11, 67, 69, 1907.

Tringa maritima Gmelin. Toll, Die russ. Polarf. d. "Sarja", pp. 56, 307, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: adult male, 14 August 1900, Dickson Bay, mouth of the Yenisei (Dr. Walter); immature, 6 September 1900, Middendorff Bay, Western Taimyr (Dr. Walter); immature, 14 September 1900, adult male, 9 June 1901, adult female, 18 June 1901, adult female, 8 July 1901, all from west coast of Taimyr Strait (Dr. Walter).

Eggs: two, 18 June 1901, three, 8 July 1901, three, 20 June 1901, all from west coast of Taimyr Strait (Dr. Walter).

During its breeding season the Purple Sandpiper inhabits the western portions of the Eurasian tundra from Spitzbergen to Eastern Taimyr.[1] It has not been recorded from the Kanin peninsula (Sect. IV), or from the region of the mouth of the Pechora (Sect. VI). It visits Kolguev Island (Sect. V) chiefly during its periodic migrations, but probably nests there at times. In all the other sections of the western part of the Eurasian tundra region, including the two islands of Nova Zembla (Sect. VIII) and the Franz Josef archipelago (Sect. IX) it breeds in considerable numbers, and at times, as for example in Spitzbergen (Sect. I), it may be the most abundant shorebird.

The Russian Polar Expedition (Walter, 1907, *et in litt.;* Birula, *l.c.;* Toll, *l.c.*) met with the Purple Sandpiper between 13 and 15 August 1900, in Dickson Bay (Sect. XI), and also during its stay at Middendorff Bay, Western Taimyr (Sect. XII). At the place of the "Sarja's" first winter-quarters, this bird was nesting in some abundance in 1901. During the vessel's passage from Taimyr to the New Siberian archipelago, it was noted in the vicinity of Cape Cheljuskin (Sect. XIII) whence it had previously been recorded by the "Vega" Expedition (Palmén, Sibir. Ishk. Fogelf., p. 314, 1887) and by that of the "Fram" (Collett and Nansen, Norw. North Polar Exp., p. 8, 1899). On the Island of New Siberia (Sect. XVI) Birula (*l.c.*) only once found the Purple Sandpiper, on 8 June 1902, but was unable to secure the individual seen, so that it is not possible to say whether it is the typical form that occurs casually in the New Siberian archipelago, or the eastern form, *Arquatella maritima couesi* (Ridgway).

In the western portions of the Murman coast (Sect. III) washed by the Gulf Stream, the Purple Sandpiper regularly winters, but deserts all the other parts of the Eurasian tundra during that season. We have at hand the following dates as to its spring arrival in high latitudes.

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[1] Our Zoölogical Museum has an egg collected 2 July 1889 by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 132, 1887) at Sagastyr, mouth of the Lena (Sect. XIV) that probably appertains to the Purple Sandpiper. In its color and dimensions it does not differ from eggs of this species from Greenland. Unfortunately I have not been able to find any specimen of this Sandpiper killed by the same traveler in the region mentioned, and for this reason I am not wholly convinced of the correctness of the identification. The egg might also belong to *Ancylochilus subarquatus* (Güldenstädt), but its dimensions, especially the breadth, are slightly greater. A skin of *Pelidna alpina alpina* (Linné) in the Zoölogical Museum taken by Dr. Bunge at the mouth of the Lena bears the inscription *Tr. maritima* (see also Buturlin, Shorebirds of Russia (in Russian), p. 188, 1906) but the egg seems to me to belong rather to the Purple Sandpiper than to the Dunlin.

Spring Migration of the Purple Sandpiper.

Spitzbergen (Sect. I)	Nova Zembla (Sect. VIII)	Franz Josef Archipelago (Sect. IX)	Western Taimyr (Sect. XI)
28 May 1861 (Danes Island) [1]	3 June 1903 [5]	8 June 1895 (Cape Flora) [6]	9 June 1901 [8]
26 May 1889 (at sea near Spitzbergen) [2]		13 June 1895 (do.) [6]	
29 May 1889 (first specimen from Spitzbergen) [2]		28 May 1896 (do.) [6]	
31 May–2 June 1889 (the bulk arrived) [2]		29 May 1896 (do., *fide* Dr. Bruce) [7]	
29 May 1900 (call-note heard) [3]		30 May 1896 (do., *fide* Dr. Koettlitz) [6]	
31 May 1900 (bird identified) [3]		27 May 1897 (do.) [6]	
Early June 1912 [4]			

[1] Malmgren, Journ. f. Ornith., vol. 11, p. 372, 1863.
[2] Walter, Journ. f. Ornith., vol. 38, p. 238, 1890.
[3] *Teste* Dr. Bunge; see Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 307, 1902.
[4] *Teste* Dr. Rempp; see Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 99, 1913.
[5] Schaanning, Bergens Mus. Aarb., 1907, no. 8, p. 66.
[6] Jackson, A Thousand Days in the Arctic, p. 402, 1899.
[7] *Teste* Dr. Bruce; see Clarke, Ibis, ser. 11, vol. 4, p. 260–261, 1898.
[8] Dr. Walter, *ll. cc. et in litt.*; Toll, *l.c.*

From these data we may conclude that ordinarily the Purple Sandpiper arrives simultaneously in Spitzbergen and the Franz Josef archipelago, between 28 May and 2 June but that in certain years, for example 1895 for the Franz Josef archipelago, it arrives a week later.

Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 102, 1900) estimate the incubation period of the Purple Sandpiper at sixteen days, but I think that it is really much longer for the observations of Evans (Ibis, 1891, p. 81) on a nest of *Pelidna alpina* (Linné) gave a period of twenty-one days while in the incubator the young hatch during the twenty-second or twenty-third day. I prefer therefore to base my calculations of the periods in the propagation of the Purple Sandpiper upon an average duration of twenty-two days for the incubation. Data as to the laying of the eggs and the time when the young hatch are presented in the following table.

The eggs of the Purple Sandpiper brought back by the Russian Polar Expedition are perfectly typical in coloring, and I need only draw the reader's attention to the great difference in the dimensions of the two eggs of the third set (below): while one of these eggs is 40.7 mm. long by 24.7 in breadth, the other measures only 33.6 mm. in length by 24.7 in breadth. The measurements and weights of the eggs are:

1. Three eggs, 20 June 1901, west coast of Taimyr Strait (Dr. Walter): 36.5 mm. x 27 (65 cg.); 38 x 26.9 (63 cg.); 39.1 x 26.7 (65 cg.).

2. Three eggs, 8 July 1901, same place and collector: 40.1 mm. x 27 (73 cg.); 38.8 x 27.4 (67 cg.); 39.1 x 27.1 (—).

Breeding of the Purple Sandpiper.

Incubationperiod estimated at 22 days		Spitzbergen (Sect. I)	Bear Island (Sect. II)	Nova Zembla (Sect. VIIIa)	Franz Josef Archipelago (Sect. IX)	Western Taimyr (Sect. XII)
The Set Completed	Premature dates	*19 Je 1896* [1]				
	Normal dates	*24 June 1907* [2] *24 June 1910* [3] 26 June 1906 [7] 29 June 1910 [3] *14 July 1910* [3] much incubated—15 days 29 June 1910 [4] *28 June 1898* [5] 28 June 1899 [5] *19 July 1899* [5] embryos covered with down—21 days) *28 June 1910* [7] 1 July 1898 [8]	*9 July 1899* [10] *14 July 1907* [2] (half incubated)	5 July 1904 [11]	25 June [12] (data lacking as to state of incubation of the eggs so that time of hatching cannot be estimated)	*15 June 1901* [13] 17 June 1901 [13] Sets contained but two eggs. *18 June 1901* [13] *20 June 1901* [13]
	Late dates	4 July 1898 [5] *9 July 1907* [2] 11 July 1907 [2] 6 July 1910 [4] *16 July 1910* [4] (incubated—10 days) 6 July 1910 [4] *21 July 1910* [4] (heavily incubated—15 days) 12 July 1881 [9] *27 July 1881* [9] (heavily incubated—15 days)				
Time of Hatching	Premature dates	11 July 1896 [1]				
	Normal dates	16 July 1907 [2] 16 July 1910 [3] *18 July 1906* [7] *21 July 1910* [4] 20 July 1898 [5] 20 July 1899 [5] 20 July 1910 [7] *23 July 1898* [8]	25 July 1907 [2] 31 July 1899 [10]	*27 July 1904* [11]		9 July 1901 [13] 10 July 1901 [13] 12 July 1901 [13]
	Late dates	*26 July 1898* [5] 28 July 1910 [4] 28 July 1910 [4] 3 Aug. 1881 [9]				

[1] Note by Trevor-Battye, Oates, Cat. Eggs Brit. Mus., vol. 2, p. 57, 1902.
[2] König, Avif. Spitzb., p. 165, 1911.
[3] Münsterhjelm, Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910.
[4] Zedlitz, Journ. f. Ornith., vol. 59, p. 322, 1911.
[5] Römer and Schaudinn, Ornith. Monatsb., vol. 8, p. 102, 1900.

3. Two eggs, 17 June 1901, same place and collector: 40.7 mm. x 26.7 (63 eg.); 33.6 x 24.7 (53 eg.).

In addition to these data we have the following notes at hand in regard to the breeding of the Purple Sandpiper. Count Zedlitz (1911) noted young in down 30 July at Cross Bay, Spitzbergen, and on 18 and 19 July in Advent Bay he saw at the same time eggs, small chicks and half-grown young; again, Professor Mathey-Dupraz (*l.c.*) found young in down on 18 July 1906 and 20 July 1910, and at the same time other young with the remiges well enough developed to enable them to fly. On Bear Island, Swenander (1900) on 4 August noted young birds about ten days old and Pearson (Ibis, 1898, p. 202) on Vaigach Island on 6, 11 and 15 July 1897 found downy young and at the same time (11 July) eggs. In Nova Zembla according to Buturlin (Shorebirds of the Russian Empire, p. 131, 1906, in Russian) at Matochkin-shar the young were half-feathered out 21 July and by 1 August the parent bird was assiduously defending its young which must still have been small. At the same place Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 66) found the first eggs of the set on 21, 24 and 30 June 1903. Further, according to Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 310, 1908) young birds were beginning to fly in mid-August while in the Franz Josef archipelago Dr. Bruce (see Clarke, Ibis, 1898, p. 261) found young birds, 27 July, in half downy plumage.

The gathering of the Purple Sandpipers into little flocks previous to their departure has been noted in Spitzbergen 31 July 1899 by Birula (1910), and by König (1911) is stated to take place by the end of July. The time of departure of the bulk of these birds from Spitzbergen was placed by Dr. Bunge (see Bianchi, 1902) at about the second week of October in 1899; and on 14 and 19 October 1899 he saw the two last lone individuals. On Kolguev Island, according to Buturlin the southward migration of Purple Sandpipers, chiefly of young birds, began about 28–29 August, and became general after 2 September. In Nova Zembla the same traveler made the following observations: in Moller Bay, where there had already been several snowfalls and the snow had remained for some days thanks to a temperature of 3° C. above zero, he met with a considerable number of these birds 22 and 23 September in small flocks, while the young birds had not yet begun to moult. On 28 and 29 September during the passage from

[6] Birula, Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 190, 1910.
[7] Mathey-Dupraz, Bull. Soc. Sci. Nat. Neuchâtel, vol.. 38, p. 46, 1911.
[8] Kolthoff, Kongl. Svensk. Vet.-Akad. Handl., vol 36, no. 9, p. 45, 1903.
[9] Cocks, Zoölogist, scr. 3, vol. 6, p. 409, 1882.
[10] Swenander, Bih. Kongl. Svensk. Vet.-Akad. Handl., vol. 26, pt. 4, no. 3, p. 15, 1900.
[11] Bilkiewicz, App. Mat. Sci. Exp. Univ. Kasan, p. 18, 1904.
[12] Jackson, A Thousand Days in the Arctic, p. 390, 1899.
[13] Walter, *in litt. et l.c.*

Matochkin-shar to the mouth of the White Sea in a heavy storm accompanied by a gale and a fall of temperature to 9.5° C. below zero he frequently saw solitary birds or flocks of two or three individuals heading in a southwesterly direction. Schaanning saw the last ones at Matochkin-shar on 1 November 1902, while A. Pike (Trevor-Battye, Ibis, 1897, p. 590) saw them as late as 5 October. Molchanow (*l.c.*) noted the last pair of these birds 22 September, while Bilkiewicz (*l.c.*), again in the month of September 1904, met with a pair, although there had already been rather heavy frosts. Finally in the Franz Josef archipelago, Dr. Bruce (Clarke, *l.c.*) recorded the departure of the Purple Sandpiper on 17 September 1895 and Jackson (*l.c.*, p. 402) on 18 September 1895 and 10 September 1896. The observations on the Purple Sandpiper in high latitudes made by the "Fram" Expedition (Collett and Nansen, Norw. North Polar Exp., p. 24, 1899) lack absolute definiteness as to locality but the farthest-northern point at which it was surely identified was at Nansen's winter-quarters in 1896, northeast of the Franz Josef archipelago.

Arquatella (=Calidris) maritima couesi (Ridgway).—A good series of specimens of the eastern form of the Purple Sandpiper was collected by members of the "Vega" Expedition in the vicinity of that vessel's winter-quarters in 1879 on the north coast of the Chuckche peninsula (Sect. XXI)(Palmén, Sibir. Ishk. Fogelf., p. 314, 1887). In the same Section at Koljuchin Bay, Amory secured, 10 August 1914, a female (Riley, Proc. U. S. Nat. Mus., vol. 54, p. 613, 1918). It appears that to the westward this species is not to be found for it is not recorded for the mouth of the Lena (Sect. XIV). But since I have not been able on the one hand to find any representative of the genus *Arquatella* from the mouth of the Lena in the collections of our Museum, and on the other hand Dr. Bunge's collections contained specimens of *Heteropygia maculata* (Vieillot), I am quite convinced that his observations on *Tringa maritima* at the mouth of the Lena relate to the latter with the possible exception of the unique egg referred to above.

? Arquatella (=Calidris) ptilocnemis (Coues).—During the stay of the "Vega" at Pitlekaj, north coast of the Chuckche peninsula (Sect. XXI), a native brought in on 3 June 1879 a male *Tringa* (no. 303) that was measured, described and preserved, but later could not be found. From the description made by Nordquist, Professor Palmén (Sibir. Ishk. Fogelf., p. 317, 1887) supposes that this specimen of Sandpiper represented *Arquatella ptilocnemis* (Coues) but he had no way of confirming this determination.

40. **Ancylochilus subarquatus** (Güldenstädt) (=**Calidris ferruginea** (Brünnich)).

(Plate 35, fig. 1–6.)

Ancylochilus subarquatus (Güldenstädt). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 236, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 157, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 4–7, 66–67, 75, 1907.

Tringa subarquata. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 198, 1902.

List of Specimens from the Russian Polar Expedition.

Skins: male and female, 7 September 1900, Middendorff Bay, Western Taimyr (Dr. Walter); adult male, 15 June 1901, adult female, 24 June 1901, adult male, 1 July 1901, adult female, 6 July 1901, all from west coast of Taimyr Strait (Dr. Walter); two adults, 8 June 1902, Charaulach Mountains, mouth of the Lena (M. Brusneff).

Eggs: four, 22 June 1901, four, 24 June 1901, four, 1 July 1901, four, 6 July 1901, all from west coast of Taimyr Strait (Dr. Walter); two (of three), no date, Kotelny Island (Dr. Katin-Jartzeff).

Local name: in Yakut, *tschorit* (Bunge).

The Curlew Sandpiper is a bird of passage in the western and eastern parts of the Eurasian tundra, and has been found to breed at the mouth of the Yenisei (Sect. XI) by Popham (Ibis, 1898, p. 515) and by Miss M. Haviland (British Birds, vol. 8, no. 8, 1915); in Western Taimyr (Sect. XII); on some of the islands of the New Siberian archipelago (Sect. XVI) and in the region of the mouth of the Kolyma (Sect. XIX) (Cape Bolschoi Baranowski—Koren, see Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 18, 1914). Buturlin (Ibis, 1906, p. 133), who stayed during the nesting season in the forest and subalpine zones on the lower course of the Kolyma, and so had no opportunity to investigate the fauna of the tundra, did not see this species except when it was on passage there in large numbers and on the north coast of the Chuckche peninsula (Sect. XXI) at Jinretlen, in the vicinity of the "Vega's" winter-quarters, where a single bird was killed 10 June 1879 (Palmén, Sibir. Ishk. Fogelf., p. 308, 1887).

I should state first of all, that the set of eggs that Goebel (Ornith. Jahrb., vol. 13, p. 115, 1902) claims to have found at Zip Navolok on the Murman coast (Sect. III) does not belong to this species. I have compared them with the four authentic sets of the Curlew Sandpiper brought back by the Russian Polar Expedition, and I have found that they differ from the entire sixteen eggs, in the tint of their ground color and in the superficial brown spots which are smaller and do not form a ring of markings around the obtuse end of the eggs. Comparison with a rather large series of eggs of *Pelidna alpina alpina* (Linné) on the other hand has quite convinced me that most of these eggs correspond absolutely with those of the set found by Goebel on the Murman coast and that this set undoubtedly belongs to the Dunlin. The same view has been expressed also by the late Dresser (*in litt.;* see Buturlin, The Shorebirds of the Russian Empire, p. 221, 1906, in Russian).

The Russian Polar Expedition (Walter, *ll.cc.;* Toll, *l.c.;* Birula, *ll.cc.*) first met with the Curlew Sandpiper 7 September 1900 at Middendorff Bay, Western Taimyr (Sect. XII). Again, in the spring of 1901 it appeared in the vicinity of the "Sarja's" winter-quarters and nested abundantly there. In the New Siberian archipelago it did not appear to be so common, but was found there nevertheless on Great Ljakoff Island by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 274 *et seq.*, 1887; specimens in our Zoöl. Mus.) as well as on Kotelny Island by Baron Toll (three specimens in our Zoöl. Mus.) and by Dr. Katin-Jartzeff. The latter succeeded in securing a set of eggs and establishing the fact of its breeding there. On the Island of New Siberia neither Birula in 1902, nor the auxiliary expedition of 1903 was successful in finding this bird;

nor did S. Tolstow meet with it in 1903 on Faddejefski Island. The auxiliary expedition under Brusneff found the Curlew Sandpiper only during its migration in the region of the mouth of the Lena. Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) recorded this bird on passage at Yeretiki, Murman coast, 15 May 1900; and its arrival on its breeding grounds at the "Sarja's" first winter-quarters was noted by Walter (*ll.cc. et in litt.*) 13 June 1901, and by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 220, 1853) on 23 May in 1843 in 74° north latitude, in Taimyr (Sect. XII). At the mouth of the Lena (Sect. XIV) Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 55, 1888) noted it on passage during several days after 13 June 1884; at the mouth of the Kolyma (Sect. XIX) Buturlin (Ibis, 1906, p. 133) observed large numbers on 10 and 11 June 1905 and finally there is the single specimen taken at the "Vega's" winter-quarters (Sect. XXI) 10 June 1879 (Palmén, 1887).

Birula has given us the following excellent account of the habits of the Curlew Sandpiper during the breeding season:

On 18 June 1901, the wind went down in the afternoon and the weather turned fine; the parts of the tundra bare of snow on the south slope of Bonnevie Isle have become very animated, particularly through the presence of *Plectrophenax nivalis* and pairs of *Calcarius lapponicus;*—on almost every spot from which the snow has melted are seen *Tringa canutus* and *Ancylochilus subarquatus;* the Knots are already paired, while the Curlew Sandpipers, the commonest Sandpiper of late in the tundra, are still flying about and running over the tundra in little flocks, without the least appearance of pairing off.

Four days later, 22 June, I found the first nest with a complete set of four eggs and on 24 June my second nest, likewise with four eggs. Evidently some of the pairs of Curlew Sandpipers had commenced nesting the day after their arrival. Since at this time it was only the southerly slopes of the hills in the tundra that were bare of snow and somewhat warmed, these Sandpipers were obliged to occupy them in preference as nesting places, and almost formed nesting colonies on the driest of these slopes. The nests were here placed rather close together so that on a space fifteen meters square one might find several pairs nesting and at times the nests were but a few paces apart or even nearer if one took into account the nests of the previous year. I surmise that the Curlew Sandpiper does not always take the trouble to make a new nest if one may speak of the simple formation of a shallow depression in the tundra moss as making a nest; it even seemed to me that many pairs contented themselves with the nests of the year before. The Curlew Sandpipers prefer to place their nests on the gentle southerly slopes of hills and always in the higher parts of the tundra that lose their covering of snow and become dry the earliest. Such places are covered with a more abundant and denser vegetation, and at the beginning of summer they still carry the dried remains of the previous year's growth. Other species of birds such as *Calcarius lapponicus* and particularly *Arenaria* delight to place their nests in such spots so that I had difficulty, particularly at first, in deciding to which of the two species of Sandpiper the nest found belonged. There were always several pairs of Curlew Sandpipers or of Turnstones flying about me, and showing the same signs of anxiety over my presence.

To give an idea of the life of the Curlew Sandpiper during its nesting season I will reproduce an extract from my diary of 24 June 1901, showing the life of the tundra from first impressions. Lying on a dry hillock, I was able with the help of a Zeiss prismatic field-glass to study the tableau of tundra life unrolled before me. My attention was attracted first of all to the dozens of Curlew Sandpipers careering about with swift and impetuous flight, at times in pairs, at times in little flocks of two or three pairs. During such aërial performances these handsome and dainty Sandpipers reminded me very much of

butterflies in temperate climes flitting about on a sunny June day. At times these masters of flight would rise to a considerable height, mingling in serried ranks in the air; again, they would join together and sweep close to the ground. Often an entire flock would alight upon the ground and make a loud clamor. Then abandoning their aërial games, the whole company would again seek the tundra and begin to run about among the dried herbage probing the soil with their curved beaks. From my observation point I soon saw a pair of Turnstones and a Curlew Sandpiper fly to a little hillock near me, showing signs of anxiety. On going to the spot I found a nest with four eggs, similar in color to those of the Curlew Sandpiper found previously. In order to be sure as to which of the two Sandpipers this nest belonged, I withdrew to some distance and watched the birds with my field-glass. After about five minutes a Curlew Sandpiper approached the spot where the nest was, and taking a turn about it, disappeared from sight amongst the vegetation. The two Turnstones took posts near by on stones and uttered anxious cries. When I again flushed the Curlew Sandpiper from the nest the Turnstones joined it, in mock pursuit, but did not come near the spot where the nest was. I went toward my observation point and saw that the Sandpiper had come back to its nest. I could readily make out among the grass its head with curved bill, uneasily turned from side to side. Before shooting it I several times flushed it from the nest, but it returned each time with less delay, and the last time almost immediately. Near at hand, at a distance of five or ten paces, I found two nests of the previous year, belonging either to the Curlew Sandpiper or to the Turnstone. The nest of the Curlew Sandpiper was placed between two little bushy hillocks in a hollow in the dry ground, near a small pool. It was on a little tussock and consisted of a hemispherical depression in the moss and compacted grass, quite unlined except for the dried moss and a very small quantity of lichen. It contained four pear-shaped eggs of a light olive color with pale brown spots chiefly disposed about the large end. They were placed in the nest in the form of a rosette with their pointed ends inward. Dissection of Curlew Sandpipers shot near their nests showed that both sexes share equally in the incubation of the eggs. Nevertheless the Curlew Sandpiper leaves its nest readily, even during the last days of incubation. Throughout this period it flushes while one is still forty or fifty paces distant, swiftly circles about one with its short quick cry —*pit-pit*—and alights at some distance on a stone to await one's departure. Since all the lower parts of its nuptial plumage are of a dark maroon color, that appears almost black at a distance, its dark silhouette stands out clearly against the light background of the sky. In flight its down-curved bill and white under tail-coverts are obvious features. It never attempts the ruse of trying to attract the enemy away from its nest but evidently depends chiefly for protection upon the concealing tints of the surrounding tundra, a view that explains why it leaves its nest so soon; if it stayed for a longer time on the nest, as the Knot does, it would run the risk of betraying the spot where the nest is. If the nest contains well-incubated eggs, the bird returns to it very soon, approaches directly toward it without any precaution, stands on the ground at a little distance, looks about it and at once settles upon the eggs.

The Curlew Sandpiper is not one of the clamorous inhabitants of the tundra. In contrast to the Turnstone it is of a quiet nature and I have never noticed that it had a disposition to quarrel with birds of the same or other species. When they are alarmed or when pursuing each other in their nuptial play, the Curlew Sandpipers utter a short, low note resembling *pit-pit*, repeated sundry times according to the degree of their excitement. When crossing the tundra at about the end of June or in early July, one frequently drives them from their nests or young. At this time the birds are generally more quiet. If they fly away, they first rise a short space from the ground, uttering their *pit-pit* note, then at some distance they mount into the air, slackening their flight and giving vent to a note of less alarm, the last syllable of which is more drawn out, like *pit-pit-piut*, then turning about in the air, they alight upon some stone in an attentive pose. In 1901 I did not succeed in finding the young of the Curlew Sandpiper because of an excursion in July toward the southerly shores of Taimyr Bay where the species was uncommon. Even as late as 27 July I saw them still in pairs, but at the same time noted rather large flocks of adult birds which showed me that most of them were through breeding and that the old birds,

having reared their young, were preparing to depart. On 7 August I observed the first flocks of young Curlew Sandpipers, consisting of birds still retaining a certain amount of down on the head.

The sets of eggs found by Birula (*l.c.*) on 22 and 24 June 1901 in Western Taimyr, contained fresh eggs while those taken on 1 and 6 July 1901 had incubated eggs. The set taken by Popham (*l.c.*) at Golchiha (Sect. XI) 3 July 1897 was slightly incubated. The sixteen eggs of the Curlew Sandpiper brought back by the Russian Polar Expedition from Western Taimyr, are pear-shaped, obtusely pointed and with a dull surface. They are described below.

1. Four eggs, 22 June 1901, west shore of Taimyr Strait (Dr. Walter; found by Birula).—The ground color varies between olive buff (Ridgway, 1912, Pl. 40) and light buff (*ibid.*, Pl. 15); in most of the eggs the tint approaches the former color, but is of a more yellowish tone. In the ground color may occasionally be noted hardly perceptible pale-gray spots. The few small superficial spots are of a buffy brown (Ridgway, 1912, Pl. 40), while some large blotches occasionally forming a wreath about the large end, are of a clove brown (*ibid.*, Pl. 40). This set shows the following measurements and weights: 35.2 mm. x 25.8 (58 cg.) (Pl. 35, fig. 3); 34.1 x 25.3 (53 cg.); 36.6 x 25.9 (56 cg.); 35.5 x 26 (58 cg.).

2. Four eggs, fresh, 24 June 1901, west coast of Taimyr Strait (Dr. Walter; found by Birula).—The eggs of this set are but very slightly different from those of the first, being distinguished only by having the ground color a little darker (deep olive buff, Ridgway, Pl. 40). They measure and weigh: 33.1 mm. x 25.7 (64 cg.) (Pl. 35, fig. 6); 36.8 x 25 (61 cg.); 36.6 x 25.8 (64 cg.); 36.6 x 25.9 (69 cg.).

3. Four eggs, incubated, 1 July 1901, same place and collectors.—The ground color of these eggs is of a deep olive buff (Ridgway, 1912, Pl. 40), darker than in those of the first set. The spots are lighter, of an olive brown (*ibid.*) and the wreaths at the obtuse ends are less marked. Their dimensions and weights are: 35.4 mm. x 26 (63 cg.) (Pl. 35, fig. 1); 33.3 x 25 (58 cg.) (Pl. 35, fig. 2); 36 x 26 (63 cg.); 35 x 26 (—).

4. Four eggs, incubated, 6 July 1901, same place and collectors.—The ground color is of an olive brown (Ridgway, 1912, Pl. 40), the large spots of a clove brown, and in certain places even of a blackish brown (blackish brown No. 2, Ridgway, 1912, Pl. 45); the lighter spots are of a buffy brown (*ibid.*). Their dimensions and weights are: 37.5 mm. x 26 (58 cg.) (Pl. 35, fig. 4); 39. 8 x 25.7 (70 cg.) (Pl. 35, fig. 5); 37 x 25.7 (60 cg.); 37 x 26 (61 cg.).

Koren (Thayer and Bangs, 1914) found at Cape Bolschoi Baranovski (Sect. XIX) 12 July 1912, two young about six days old, and between 16 and 18 July of the same year, at a distance of ten leagues from the first place, a nesting colony of this species. He

supposes that the young ones eluded him by hiding in the grass for he did not succeed in securing any.

According to Walter (*in litt.*) and Birula (*l.c.*) flocks of immature Curlew Sandpipers leading a roving life in the tundra were observed after 7 August 1901; between 9 and 13 August 1901, the flocks of these birds became more numerous and at about that time disappeared from Taimyr. Miss Haviland (Ibis, 1915, p. 397) noted the departure of this species from Golchiha, at the mouth of the Lena, on 15 August 1914.

41. **Tringa** (=**Calidris**) **canutus canutus** Linné.

Pl. 36; Pl. 37, fig. 1–10 (in vertical columns).

Tringa canutus Linné. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 237, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 158, 1902. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 198, 1902. Birula, *ibid.*, vol. 18, no. 3, p. 94, 1903. Brusneff, *ibid.*, vol. 20, no. 5, pp. 181, 183, 192, 1904. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 4–7, 11–17, 66–68, 80, 1907. Toll, Die russ. Polarf. d. "Sarja," pp. 308, 323, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: adult male, 9 June 1901, adult male, 22 June 1901, adult female, 30 June 1901, adult male, 6 June 1901, adult male and three young, 11 July 1901, adult male and four young, 29 July 1901, adult male and four young, 13 July 1901, all from west coast of Taimyr Strait (Dr. Walter); three young, 6 July 1902, immature male, 24 July 1902, immature female, 4 August 1902, all from Kotelny Island, New Siberian archipelago (Dr. Katin-Jartzeff); adult female, 6 July 1902, adult male and two young, 11 July 1902, adult and four young, 13 July 1902, four young, 5 August 1902, three young, 8 July 1902, all from the Island of New Siberia (A. Birula); adult female, 29 June 1901, near Malakatyn, Kotelny Island, New Siberian archipelago (O. Cionglinski); immature, 26 August 1901, Camp Michailow, Kotelny Island, New Siberian archipelago (O. Cionglinski); immature male, 1900, Island of New Siberia (M. Brusneff); adult and young, 1 July 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff); adult, 22 June 1903, Roshin promontory, Island of New Siberia (M. Brusneff); adult and two young, 12 July 1903, Camp Yelisseyeff, Kotelny Island, New Siberian archipelago (P. Olenin).

In alcohol: young, 1 August 1902, Island of New Siberia (A. Birula).

Eggs: one, 22 June 1901, three, 6 July 1901, one (missing), 12 July 1901, all from west coast of Taimyr Strait (Dr. Walter); three, 14 June 1902, Besborodovka River, north of Nerpalach, Kotelny Island (Dr. Katin-Jartzeff); four, 6 July 1902, two, 24 July 1902, all from the Island of New Siberia (A. Birula); four, 1 July 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff); four, 1 July 1903, Faddejefski Island (S. Tolstow).

Local names: in Yakut and Tunguse, of the Yava region, *kógi* or *kóhi*, which represents an imitation of the characteristic note of this Sandpiper (Birula, *l.c.*).

The Knot has been once observed as an accidental visitor in Spitzbergen (Sect. I) (an adult male, 12–14 June 1889, on Berentine Island, Deevielbai—Walter, Journ. f. Ornith., vol. 38, p. 247, 1890); it is found occasionally as a migrant on the Murman coast (Sect. III), and has once been reported by Payer as seen between the Franz Josef archipelago and Nova Zembla, but the latter observation has been doubted and Clark

(Ibis, 1898, p. 260) is probably right in referring it to *Arquatella maritima maritima* (Brünnich). In the Eurasian tundra region, between the White Sea and Taimyr, the species has not been observed either in the breeding season or on migration. In Western Taimyr (Sect. XII) Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 219, 1853) found but a single dead individual, 12 September, while the Russian Polar Expedition was the only one to establish its nesting in abundance in these latitudes. Up to that time the Knot had been recorded breeding in different parts of the arctic regions of America, but explorers had only succeeded in occasionally securing downy young without having been able to find the eggs of this species. To the late Baron Toll (1909, p. 323) evidently belongs the honor of discovering the eggs. He tells us that he secured the first set of this species in 1886 on Kotelny Island, but that the eggs reached the Zoölogical Museum in bad condition. Copley Amory took a female of the Knot 17 August 1914 at Chaun Bay (Sect. XX) that Riley (Proc. U. S. Nat. Mus., vol. 54, p. 613, 1918) has referred to the Aleutian form (sub *Canutus canutus rogersi* Mathews). On Wrangel Island (Sect. XX) Crawford obtained it (Snyder, Univ. Toronto Studies, biol. ser., no. 28, p. 12, 1926).

The Russian Polar Expedition met with the first Knots in 1900 during its stay at Middendorff Bay, in Western Taimyr. In the vicinity of the "Sarja's" first winter-quarters this bird in 1901 was nesting in considerable numbers (Walter, *ll.cc. et in litt.;* Birula, Toll, *ll.cc.*). In the New Siberian archipelago it was also found in abundance and we have at hand the following notes for the different islands of this archipelago. In 1886 Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 273 *et seq.*, 1887) found the Knot on Little and Great Ljakoff Islands; and Baron Toll on Kotelny Island 21 June and 2 July (specimen in our Zoöl. Mus.) that is, evidently, during the breeding season. In 1901 the auxiliary expedition under O. Cionglinski obtained an adult female, 29 June, in the vicinity of Malakatyn and on 26 August a young bird near Camp Michailow (*coll. Russ. Polar Exp.*). In 1902 this species was found breeding in the vicinity of the "Sarja's" second winter-quarters, at Nerpalach Bay, Kotelny Island. Specimens were secured here by Dr. Katin-Jartzeff (*in litt. et coll. Russ. Polar Exp.*) and the species was observed also on Balyktach River by Naval Lieutenant Kolchak (*in litt.*). Again, in 1903 the latter saw the bird in great numbers in the neighborhood of Camp Michailow (*in litt.*) while Olenin secured an adult and two young at Camp Yelisseyeff (*coll. Russ. Polar Exp.*). On Faddejefski Island S. Tolstow (*in litt.*) noted the arrival of this Sandpiper 4 June 1903 and on 1 July took a set of four eggs (*coll. Russ. Polar Exp.*). Finally on the Island of New Siberia the Knot was very common in 1902, and Birula not only made a very fine collection of adult birds, young and eggs, but also had the good fortune to be able to study at leisure the unknown habits of this

bird during its breeding season. In 1903, the auxiliary expedition under Brusneff (*in litt. et coll. Russ. Polar Exp.*) again found the Knot on this island in abundance and supplemented Birula's observations through finding this species likewise at Cape Roshin and in the Derewjannyja Mountains.

Birula has given us so detailed and complete a picture of the life of the Knot during the breeding season that I find it absolutely necessary to give the reader a complete translation of the Russian text. He writes:

The Knot was first met with by the Russian Polar Expedition on its autumnal migration in Middendorff Bay, Western Taimyr. During the day I saw no migrating flocks of Sandpipers; on the contrary large companies consisting chiefly of *Limosa lapponica*, among which were but two or three individuals of *Tringa canutus*, were leading a nomadic existence by day in the vicinity of the bay, evidently seeking for food on the tundra. But during the night of 27 28 August, having been delayed during one of my excursions, as I passed near a great sand shoal in Wesselowski Bay, I had occasion to observe the very active migration of different species of Sandpipers. On the sand shoal I first noted a large and noisy flock of *Limosa lapponica*. These long-legged shorebirds were at times running actively about on the sand, and at times all took wing, circled about me, then alighted once more on the sand. At a shot from my gun the entire flock sought the opposite shore and was lost to view in the darkness. Its place was taken by a flock of Knots that came in from the north or northeast and was chiefly composed of adult birds beginning their moult. These flocks stayed but a very short while on the sand beach, and were succeeded one after another by new flocks coming from the north. They consisted for the most part of only a single species; but occasionally contained also a few individuals of other species. The flocks of *Limosa lapponica* always contained a certain proportion of *Tringa canutus* and at times the Least Sandpipers, *Limonites minuta*, accompanied them. I succeeded in shooting from the flocks of Knots, composed chiefly of adult birds, a few specimens with bare incubation spots on the breast. This discovery greatly delighted us, for it gave us hopes of finding the nesting grounds of this Sandpiper in case of our wintering in Taimyr. And indeed, in the following year, it appeared in considerable numbers in the vicinity of the "Sarja's" winter-quarters and nested there in abundance. I should add that on its return migration in autumn about 28 August, the last flocks of this Sandpiper had passed Middendorff Bay, for neither in the vicinity of the Bay nor farther to the northeast did I succeed in seeing them again, although other shorebirds, especially *Crymophilus fulicarius* and *Arquatella maritima* remained in Western Taimyr until 11 September. I should add that the western coast of Taimyr, which in these latitudes has an almost northeasterly direction, represents a very important flight line, especially during the autumn migration. I satisfied myself in 1900 and 1901 that a considerable number of birds make use of the route along the coasts of Western Taimyr, such as the different species of shorebirds, the Snow Buntings and particularly the Barnacle Geese, which in summer inhabit in large bodies the seacoasts of Taimyr and the mouths of the rivers.

The preliminary reports of Dr. Walter and myself contain the statement that the Russian Polar Expedition succeeded in establishing the fact that *Tringa canutus* nests in Taimyr and in the New Siberian archipelago. During the Expedition's stay in the latitudes of Taimyr, I did not undertake systematic observations on the bird-life and for this reason do not find in my diaries any detailed accounts of the habits of the Knot in Western Taimyr. But in 1902, while spending the entire summer on the Island of New Siberia, I had occasion to gather complete material on the biology of this Sandpiper. I shall therefore limit myself to giving a brief account of my observations in Taimyr, and shall endeavor to produce a more nearly complete picture based on systematic data gathered during the stay at the Island of New Siberia.

In the spring of 1901 at the "Sarja's" anchorage, the first individuals of the Knot were seen and taken on 9 June. They had probably arrived the evening before, but certainly not before 7 June, be-

cause that day the temperature had remained at 9° below zero centigrade and did not rise until the following day, remaining all through the day at about 0° centigrade. Moreover it was especially on 8 June that the arrival of other shorebirds in quantity was observed. At all events after 9 June *Tringa canutus* was not rare on the sunny slopes of the hills in the tundra that were bare of snow, and here the birds stayed, sometimes solitary individuals, sometimes pairs, while in all directions their calls might be heard. By 18 June I found them only in pairs in the vicinity of their nests, although at this time they were not yet practicing the strange maneuvers to which they resort to draw an enemy away from their nests. A nest of the Purple Sandpiper was found this same day containing a complete set of eggs, showing that the shorebirds, and the Knot among them, had commenced laying some days before. Yet it was not until 3 July that I succeeded in finding a nest with three eggs, well advanced in incubation. On 11 August the first young birds were found, three of which had hatched while the fourth had not yet broken from the egg. These data, it seemed, established the length of the first period in propagation, that is from the laying of the eggs till the hatching out of the young, as approximately twenty to twenty-five days. About the last of July (1 August, to be exact) we found young birds already able to fly though but poorly. Almost simultaneously began the departure of the Knots for the south, at first in family groups. Since the Expedition left Western Taimyr by 26 August we were unable to secure complete data as to the biology of the species for this year in Western Taimyr, but as in the previous year we were able to determine that the Knots had left Taimyr by the time the Expedition departed. I have already recorded the departure of the adults by 24 July. They frequently flew off in company with *Limosa lapponica*. The flocks of young Knots were hardly seen at all on the tundra in the autumn, quite in contrast to the habits of the other shorebirds, for the flocks of young Curlew Sandpipers, Least Sandpipers and particularly *Crymophilus fulicarius* remained there a much longer time.

In 1902, I arrived at the Island of New Siberia on 26 May. At this time the air temperature, especially at night, was rather low, reaching −15° C., but during the day it rose; after noon it rose to −3° C. or even −2° C. for a time so that melting took place on southerly slopes bare of snow. The arrival of the migratory birds had begun some while before: the *Plectrophenax nivalis* and *Erionetta spectabilis* had appeared a little time previously, but only a few at a time or even advance guards. The arrival of the great body of the birds had not yet commenced. On 30 May, the noon temperature rose to 1.6° C. and on this day appeared the first migrant from the south, *Stercorarius pomarinus*. On 5 and 6 June, with a moderate east-southeast wind the arrival of the greater part of the birds took place. As elsewhere at the northern limits of the migration routes, I was unable to observe at the Island of New Siberia any regular passage of flocks of birds in a south-to-north direction. The tundra, hitherto silent, now resounded with the notes of thousands of birds. From the summits and slopes of the little hills stained by the melting snow and from the pebbly shores of the sea were to be heard the melodious notes of *Tringa canutus*, the strident cries of the Turnstone, and at times the voices of *Larus vegae* [= *L. argentatus birulai* Sushkin]. Evidently the birds that had come to spend the summer in New Siberia had upon their arrival scattered out over the tundra. On 5 June I saw the first three Sandpipers—*Calidris arenaria*—headed northward along the seashore. The fact that the beetles and spiders were coming to life and beginning to appear at a time when the temperature even during the day did not rise above zero centigrade and when there was still a frosty feeling at night, may be explained by the considerable warming up of the ground. Simultaneously with the increase in melting there appeared in great numbers the only beetle of any size in these countries, the *Chrysomela rufipes* Mén. The meager life of the island had awakened at the moment when the Sandpipers and other small birds arrived so that they were able to find food, although in rather moderate amount.

The Knots had evidently arrived already paired at the Island of New Siberia, for from the first I saw pairs only. It is not until some while afterward that small flocks appear, made up, as it seemed to me, of immature birds that had not yet bred. Probably the paired birds at once set about making their nests and laying their eggs, as one might conclude from their behavior and the courtship evolutions of the males. On the blackish areas of ground bare of snow, between snow banks, one might frequently see

pairs of *Tringa canutus* quietly hunting for food in the dry vegetation of the previous year. Although these were adult birds, they showed very little fear and allowed me to approach readily within gunshot. A pair if pursued, begins to run along the ground, stretching up their necks and turning to face the object of their alarm. Sometimes the Knot lifts up one wing after the manner of *Arquatella maritima;* at the same time both sexes, or more often the male, give the resounding cry of alarm, which may be well rendered by the syllables *kve-kvé, kve-kvé.* The bird gives this cry at the moment when it sees itself pursued or as it flies off. During almost the entire summer and especially during the first three weeks after its arrival, the tundra resounds with the courtship notes of the male Knots. It is decidedly the most characteristic love song of the tundra in Taimyr and New Siberia; at the same time it is the most sonorous of bird notes, and in spite of its simplicity one of the most pleasing. At the beginning of his courtship play the male Knot rises at once to a considerable height, about a hundred feet, makes a few quick strokes with the wings and then soars for a while in air, uttering its sharp and sonorous call—*kou-hi; kou-hi; kou-hi;* repeating these syllables three or four times. Ordinarily the bird ends this first part of his song by another series of notes which are louder and deeper, and which I might transcribe by the syllables, *kouit—kouit,* once or twice repeated. In the first part the first syllable is usually accented —as *koú-hi;* sometimes it is the second syllable, when he gives the note like *kou-hi.* So characteristic of the Knot is this courtship song that the Tunguses and Yakuts of the Yana region call this Sandpiper *kógi,* an onomatopoeia. I was unable to note any regularity or relation to the time of day in these courtship performances. The notes of the Knot resound at all hours not only of the day but of the night, if one may speak of night in the summer of arctic countries. Even a thick fog that may hang for several days in the cold, still air does not deter the Knot in his courtship evolutions.

As a situation for its nest the Knot selects a slope or the summit of a hill where it makes a slight hollow in the turf. The spot chosen may not even be always a dry one. In Taimyr I once found a nest of this bird [Plate 25, fig. 1] in a rather moist spot between little pools of water. The nest itself was a rounded cup about 5 centimeters deep and 11 centimeters in diameter; the hollow in which it was contained, had a depth 7 or 8 centimeters greater but the bottom of the nest is flat because it is lined with a thick layer of dry lichens. In the nests of *Tringa canutus* and other Sandpipers I have always found as an inner lining chiefly the lichen, *Thamnolia vermicularis* (Swartz) Schaer, which consists of rather thick white tubes, hollow inside. This lichen is generally abundant in the tundra. It is not by chance that it is found in the nests of the Knot, for in view of the amount that these nests contain it must be especially gathered by this Sandpiper. More rarely the nest lining consists of *Dufourea arctica* Hooker, a lichen of yellowish cylindrical tubes, hollow within, and with blunt ends. When one recalls that these stalks of these two lichens are evidently filled with air, one must admit that they are valuable material for nest lining. It is obvious that this lining composed of soft tubes filled with air forms an excellent insulating layer from the cold and frozen ground on which the nest is made. It appears that from the commencement of incubation the bird protects its nest very carefully and during the last days of incubation it does not leave it until almost stepped upon by a person approaching. When flushed from the nest, the Knot fluffs out its feathers, drags its wings upon the ground and begins to run about the nest with loud and agitated cries; sometimes it throws itself on the ground and beats its wings like a wounded bird. On approaching the bird, it would run a few paces ahead always imitating a wounded bird, until it was some twenty or thirty paces from the nest. Then evidently supposing the nest was safe, the bird decided to take wing, rising at first but a short distance from the ground, then ascending to a height. I then returned near the nest, after the bird had gone, when the Knot came back, threw itself almost at my feet and recommenced its ruse to draw the troublesome intruder away from its nest. When the Sandpiper succeeds in deceiving the enemy, it begins to wheel about him on rapid wing, uttering its characteristic cry of alarm. There is no doubt that the maneuvers just described, as practiced by this Sandpiper are very effective where it is a case of defending the nest from the arctic fox or that other brigand of the tundra, the weasel. So well does the Sandpiper imitate a wounded bird fluttering over the ground or at times even over the water, that the beast of prey at once starts to pursue it and so loses sight of the nest.

I was able to prove this to my satisfaction in the case where the dog found a nest of the Knot. He dashed away in pursuit of the bird, and having been drawn off to some distance did not again return to the nest. Once the defense of the nest cost the bird its life for the dog succeeded in seizing it as it ran under his feet. Occasionally, however, the Knot does not attempt these ruses to distract the enemy's attention from the nest. A nest that I found on the Island of New Siberia was abandoned by the bird when I approached within forty paces of it. It flew directly away in silence, so low that its wings nearly touched the ground. After it had gone about a hundred paces, it mounted in the air and commenced to circle about me out of gunshot, sounding its usual cry. I therefore lay down to watch it at a distance of about fifty paces from the nest, and after three or four minutes it went back to its nest and I shot it.

Almost always both male and female stay in the vicinity of the nest, and it is clearly the former that shows more solicitude for his progeny than the latter. Near all three of the nests that I found in Taimyr and on the Island of New Siberia I killed the male birds; likewise in all cases where I succeeded in finding young birds, the males showed the more anxiety and were more assiduous in trying to draw off the enemy.

On the Island of New Siberia I did not succeed in finding the first nest of the Knot until 6 July. It contained four eggs with young already covered with down and some time afterward I began to find broods of young of this species. I may add that one cannot find the nest of *Tringa canutus* except by chance. On several occasions all my efforts were fruitless for the bird once frightened from the nest, in particular during the first part of the breeding season, does not return for a long time; it is only at the end of the incubation that it leaves the nest for an inconsiderable while. The difficulty of finding the nest of the Knot is further increased in that this Sandpiper is rather unsociable and during the time when the eggs are being incubated it avoids association not only with its own kind but with other birds as well, and for nesting sites selects barren places far removed from these ashore where, at least in the New Siberian archipelago, bird-life is chiefly concentrated.

While the greater part of the *Tringa canutus* on the Island of New Siberia were engaged in incubating eggs a certain proportion of these birds, apparently few in number, inhabited the tundra in little flocks of from six to ten individuals. I met with these flocks but seldom, not more than three or four times. One such flock I saw 5 July, consisting of nine birds, all in summer plumage, at a time when all the birds were running about over the tundra in search of food. At my approach, the entire flock took wing with the usual clamor of alarm, not allowing me to come within gunshot; but presently some of them rose to a height and flew off with the characteristic nuptial flight in different directions, at the same time sounding their peculiar call-note, *koú-hi*. But these evolutions were not long continued, and soon all the members of the little company sought the tundra once more, mingling in an eager and active flock as one occasionally sees in the nomadic life of young birds in autumn, before their departure southward. In Taimyr I have also observed such flocks of adult *Tringa canutus*, leading a wandering existence in summer. For example I saw on 21 July a large flock made up of equal numbers of *Limosa lapponica* and *Tringa canutus*, the latter all in summer plumage. On 24 July I again observed a flock of these two species of shorebirds passing southward along the seacoast. Perhaps these flocks consisted of immature birds of the previous year that were not yet breeding, but unfortunately I did not succeed in securing a single bird from such a flock.

On the Island of New Siberia I noticed the first broods of young in early July and on 11 July I secured two very small chicks that were accompanied by one of the parent birds. On the same date in 1901 I found in Taimyr the first nest that contained in addition to remains of eggshells, one egg already pipped by the young one it contained. The three other young, that had evidently run away at my approach, were discovered at a short distance from the nest, and one of them still carried bits of eggshell. I had therefore come upon this brood just as the young were hatching, but they nevertheless were already strong enough to escape by leaving the nest. This fact is further interesting since it shows that the young as soon as they hatch, recognize the notes and maneuvers of alarm given by the parent birds. After the young are hatched the old birds conduct them from the barren hilltops to the lower ground covered with

more abundant vegetation, and interspersed in the tundra with little pools of water that teem with insect larvae, large Branchipoda and Oligochacta. These pools are likewise frequented by swarms of mosquitoes busy laying their eggs in the water. Other shorebirds, such as *Arenaria interpres* and *Calidris arenaria* also gather in these places, so that *Tringa canutus* passes the second period of the breeding season in a more varied company. It is very likely that the association with the Turnstones is of some advantage to the Knots, since the former's loud alarm-notes warn all the inhabitants of the locality of any impending danger and it is a furious and fearless enemy of the marauders of the tundra, particularly of the different species of *Stercorarius*. The Turnstone is the only one that rushes to meet the Jaegers and is successful in driving them away from its nesting site, whereas the Knot is of a very peaceable nature. As I have already pointed out the two species of Jaeger, *Stercorarius crepidatus* and *Stercorarius parasiticus*, are the most redoubtable enemies of all the small birds along the coasts of the Siberian Arctic Ocean. The arctic foxes and the weasels are too few to cause serious damage through the destruction of eggs, whereas the Jaegers are everywhere abundant in the tundra and are constrained to devote themselves to preying on its population. Their food consists chiefly of lemmings and the eggs and young of shorebirds.

The young of *Tringa canutus* as well as those of other species of shorebirds, can hide in a most wonderful way in time of danger, being chiefly protected by their peculiar coloration, consisting of little black and white spots disposed on a background of brown that harmonizes perfectly with the tints of the lichen-covered tundra. When the parent bird sounds its *kwi-kwi* or *toué-toué* of alarm, the chicks immediately scatter in different directions and crouch flat on the ground among the parti-colored lichens. Even in places bare of such other vegetation as *Potentilla fragiformis* and *Papaver nudicaule* and covered only with small lichens it is impossible to discern the little chick if he remains perfectly still. I have often had to give up the search and leave the spot; but as soon as I had withdrawn to a sufficient distance the parent bird would come back to it and with my field-glass I could see the young ones come running from different directions at the parent's call.

The behavior of *Tringa canutus* when protecting its young is quite different from that shown when the nest contains eggs. When an enemy approaches the spot where the young are hiding both parents begin to fly all about uttering their usual note. Each in turn, the old birds approach the enemy that has disturbed them, and then fly straight away, very close to the ground, sometimes actually touching the earth with their wings. At times one of the parents will withdraw to some distance, displaying a certain indifference to what is going on; usually, if not always, this is the female. When the enemy has departed and the young are no longer in immediate danger, one of the parents comes back toward them. It no longer sounds its alarm-note, rises some four to six meters above the spot where the young are hidden, ceases fluttering its wings, lowers them slightly and utters its call-note—*kjut-kjut* or *tuouit, tuouit*, given in a quieter and more encouraging tone. This call-note it repeats several times, occasionally adding its usual mournful cry—*kou-hi, kou-hi*. The difference in intonation between the alarm-note given on the approach of danger and the call-note of reassurance is so great that I do not doubt that the bird by the latter note tells its young that the danger is over and calls them together. In fact, after the parent bird alights on the tundra, the round heads of the young birds begin to appear one after the other about it. In case both parents are killed, the young birds often show no sign of life for over an hour, though finally, no longer hearing the alarm-note, they begin one by one to call and run about on the tundra, stretching up their necks and looking behind them. On 13 July I secured a brood of young in which the remiges were beginning to grow; but it was not until three weeks later (1 August) that I saw young birds that were able to fly. These young ones did not hide on the approach of danger nor did they cease calling even when the parent bird flew about an approaching person giving its usual resounding cry. In such cases the young birds allowed me to approach very near, and at a shot three of them flew off very unskilfully and alighted again at some distance on the tundra. During this time the young birds still retained their habit of running away or flying off in different directions at a call from one of the parents. But as they then fly off to a considerable distance, the parents have some difficulty in reassembling them. The young birds in question still retained considerable down on the head, and particularly

at the base of the bill; the tail did not reach to the tip of the folded wing, and the belly had a yellowish tint or was of a pale ocher color.

These are the last days of family life for the Knots. The young birds already are beginning to leave their parents and gather into considerable flocks which, before their departure to the south, lead a nomadic existence on their native tundra.

Long before the first frosts, which in 1902 came about the first of September on the Island of New Siberia, the young *Tringa canutus* were already on the wing and had gathered into flocks, so that when the frost did come they were ready to depart south. The adult birds also, sometimes by families, sometimes in flocks, began their autumnal migration rather early. In Taimyr, 2 August, I observed in Walter Bay the following scene: a flock of *Tringa canutus*, consisting of two adult and four young birds, that evidently belonged to a single family, was flying along the seashore in a south-southwesterly direction at a considerable height, following a precise course with deviation. The flight of the young birds was still awkward as would be expected at so early a time. They were easily distinguishable from the adults by their flight, the light tints of their plumage and by their shrill voices; and I was able to watch them for some while by the aid of my field-glasses. The old birds flew near the young ones, sometimes at a greater height, sometimes at a lower elevation, and either went ahead of them or kept by their sides; from time to time the parent birds uttered peculiar calls as if to encourage their progeny. It was evident that the young birds were making their first long-distance flight and that the old birds were endeavoring to depart in good season from the Taimyr tundra which had offered them favorable conditions and sufficient security during the breeding season but which was too sterile for them to maintain themselves there. Probably the Knots do not leave the more distant islands of the New Siberian archipelago so early because at this time the young birds are not in a condition to make the passage from the Island of New Siberia to, for example, the mainland, for this passage is almost 300 kilometers and the width of the strait between Kotelny Island and Little Ljakoff Island is about 90 kilometers. However, after 5 August I noticed a few flocks of young Knots; on exactly this date, I saw on the slope of a hill, covered with some little pools of water, a flock of twenty to twenty-five young Knots that already could fly well. Among them was an adult bird that had not yet moulted, and so, because of his dark tints, was a rather striking figure among the young birds. He ostensibly played the part of commander of the flock, but the young birds no longer obeyed his orders so promptly as formerly. As I drew near this old bird flew toward me and circled about me with the usual cry. Some of the young birds uttered the same note but in a weaker and less distinct tone, on a higher key. At my first shot the entire flock flew off to a little distance, alighted once more on the tundra and began to search for food in a rather indifferent manner. The old bird persisted in circling about me, but kept out of gunshot. At times, when it passed the place where the young birds were on the tundra, it set its wings and gave vent to its call—*kiuit-kiuit*—as if to arouse them. It took the greatest pains to force the young birds to leave my vicinity, but all its efforts were futile; after several persistent appeals the flock of young birds started toward the old one but not suspecting the danger of my presence chose the route nearest to me. Not until after several gunshots did the flock finally hide to some extent in the gray tundra. The adult bird continued for a long while to circle about me until I succeeded in shooting it. It proved to be a male still retaining its rather worn summer plumage and had not yet begun to moult. It was very thin while the young birds were quite fat. The stomachs of these birds were filled with minute pebbles and a black mass in which could be distinguished the remains of small oligochactes and dipterous larvae, which at this time in great abundance peopled the streamlets and pools of the tundra. Of the nine specimens that I succeeded in shooting only four had the remains of down at the base of the bill. At the same time those specimens that still retained some down on the head had more ochraceous on the belly than those which had already moulted their first (juvenal) plumage.

The flocks of young *Tringa canutus*, at times of rather large size and consisting of from thirty to fifty birds, remained on the tundra but a very short time longer. On 7 August I saw the first of these flocks and on 10 August the last. After this date, it was only on 15 August that I saw single individuals of this

Sandpiper, as they were leaving the island. Throughout the time of the autumnal migration from the Island of New Siberia I stayed at the same place on the west coast of the island in the region of Blagowestchenskij Strait which gave me the opportunity of watching the course of the departure of the birds. My camp had the additional advantage of being situated near the mouth of a small stream that had formed at the shore of the sea a large bank of sand and mud which became dry at the intervals of ebb tide. This bank during the latter days of the autumnal migration was the haunt of flocks of different kinds of Sandpipers that sought food there. On 8 August I saw considerable flocks of *Tringa canutus* on this bank, a species that I had not seen there previously. These flocks consisted exclusively of young birds. The next day, 9 August, these flocks were equally numerous, and during ebb tide when the bank was uncovered for a great extent, hundreds of Knots occupied it, energetically probing the mud; but when the tide again covered the bank, the flocks left the seashore and returned to the tundra where they stationed themselves in the neighborhood of streams and pools. On 10 August there was but a limited number of Knots on this bank and the flocks of *Crymophilus fulicarius* predominated. On the days following I did not see a single bird there, although on the tundra I noted solitary individuals and belated birds up to 15 August. In giving this picture of the Knots' departure from the Island of New Siberia I have made no mention of the departure of the adult birds of this species. Observations on this moment in the life of the Knot are lacking because I did not succeed in establishing it. Evidently the adult birds, after the young had learned to fly and had gathered into flocks, quickly deserted the sterile island for the mainland. It is possible that I was unable to record the exact time of their departure because the flocks of adult Knots may strike directly south from the southern coast of the Island of New Siberia. Likewise I am not in a position to say whether the flocks of young Knots went by this route for I had not visited the southern coast at this season. One may grant that the flocks of young *Tringa canutus* preferred to reach the nearest island to the westward, that is, Faddejefski Island, and took their course thence to the mainland, passing the Little and Great Ljakoff Islands. At all events, I have several times had occasion to note that in leaving the Island of New Siberia the flocks of young Knots headed directly west or southwest and passed Blagowestchenskij Strait. After 15 August I no longer saw any Knots, either adults or young. On the very evening of the day when I saw the last solitary individual the air temperature fell below zero centigrade, a considerable amount of snow fell, and remained on the ground without melting up to the time of severe cold weather.

The eggs of the Knot brought back by the Russian Polar Expedition comprise seven sets and offer the opportunity for giving the following details as to their shape, color, measurements and weights. The shape, as reproduced exactly in Plate 37 is sub-pyriform, and rather oval at the pointed end; the coloration, however, is less satisfactorily reproduced since the violet-tinted background of the entire plate alters to a certain degree the ground color of the ten eggs there shown.

1. One egg, 22 June 1901, western coast of Taimyr Strait (Dr. Walter).—The ground color of this egg is a pale olive buff (Ridgway, 1912, Pl. 40), the little spots as well as the large spots washed with olive brown and the little ones with citrine drab. Dimensions and weight: 44.5 mm. x 30.6 (105 cg.).

2. Three eggs, 6 July 1901, same place and collector.—The ground color of these eggs is of a light grayish green (yellowish glaucous, Ridgway, 1912, Pl. 41), the deeper spots of a deep olive gray and the superficial ones, chiefly grouped about the obtuse end, of a bone brown. Dimensions and weights: 42.1 mm. x 29 (80 cg.); 41.6 x 29.1 (98 cg.) (Pl. 37, fig. 3); 44.3 x 29.6 (95 cg.) (Pl. 37, fig. 5).

3. Three eggs, 14 June 1903, Besborodovka River, north of Nerpalach, Kotelny Island (Dr. Katin-Jartzeff).—The ground color of the first of these eggs is of an olive buff, that of the two others similar but of a darker tint, deep olive buff. The pale spots of the ground color are of a smoke gray (Ridgway, 1912, Pl. 46); the less conspicuous superficial spots are of an olive brown (*ibid.*, Pl. 40) while the more conspicuous ones are of a fuscous black (*ibid.*, Pl. 40). Dimensions and weights: 42.2 mm. x 29 (91 cg.); 44 x 28.5 (95 cg.); 41.7 x 29 (98 cg.) (Plate 37, fig. 9).

4. Four eggs, 6 July 1902, Island of New Siberia (A. Birula).—This set is characterized by the complete similarity in color of all the eggs. Their ground color is of an olive buff (Ridgway, 1912, Pl. 40). The deeper pale spots are of a smoke gray (*ibid.*, Pl. 46) and rather small, scattered over nearly the entire surface of the eggs. The large superficial spots are of an olive brown. Dimensions: 44 mm. x 31; 44.2 x 30.7; 43 x 30.6 (Pl. 37, fig. 6); 44 x 31.

5. Two eggs, 24 July 1902, Island of New Siberia (A. Birula).—The ground color is of an olive buff; the deeper spots are rather few and of a smoke gray (Ridgway, 1912, Pl. 46) while the more superficial ones are very small, of an arrowhead shape and buffy brown in color. Dimensions and weights: 43.2 mm. x 29.2 (96 cg.) (Pl. 37, fig. 10).

6. Four eggs, 1 July 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff).—The coloration of these eggs is rather varied. The two eggs marked *a* and *d* have the ground color a pale olive buff (Ridgway, 1912, Pl. 40), the deeper pale spots of a grayish olive (*ibid.*, Pl. 46); and the superficial spots sometimes of a buffy brown (*ibid.*, Pl. 40), sometimes of a dull brownish black (fuscous black, *ibid.*, Pl. 46). The egg marked *b* has the ground color of a tint approaching yellowish glaucous (*ibid.*, Pl. 41); while that marked *c* is of a yellowish buff (tilleul buff, *ibid.*, Pl. 40). The deeper spots of these two eggs are of a light grayish olive (*ibid.*, Pl. 46) and the superficial ones different shades of brown (natal brown and bone brown, *ibid.*, Pl. 40). Dimensions and weights: 42 mm. x 31.7 (104 cg.); 44.3 x 31.1 (105 cg.) (Pl. 37, fig. 1); 43.3 x 30.2 (96 cg.); 43 x 31 (107 cg.).

7. Four eggs, 1 July 1903, Faddejefski Island (S. Tolstow.).—The ground color of the eggs of this set is of a pale olive buff (Ridgway, 1912, Pl. 40). The deeper spots are of a smoke gray (*ibid.*, Pl. 46) and the superficial ones vary between different shades of brown (buffy brown, bone brown, *ibid.*, Pl. 40; and fuscous black, *ibid.*, Pl. 46). Dimensions and weights: 40.9 mm. x 29.6 (93 cg.) (Pl. 37, fig. 2); 40 x 29.1 (92 cg.) (Pl. 37, fig. 7); 43 x 29 (89 cg.); 42 x 29 (—).

The Russian Polar Expedition brought back in all twenty-six young in down of the Knot. All these were preserved in alcohol and made into skins at Petrograd. Although

the skilful taxidermist of the Museum, M. Kolin, has done his best with these and most of them are very fine specimens, I may express my suspicions that the color tints of most of these young have suffered to a certain extent and are less bright than in the natural state. I have selected for description the specimens with the brightest tints, and trust that they differ but very little from their natural ones. The colored plate (Plate 36), prepared by B. Watagin of Moscow, shows two young of different ages, one just hatched, the other probably some ten days old. In the newly hatched chicks the ground color of the forehead, the region around the eye and the fore neck are of a light pinkish buff (Ridgway, 1912, Pl. 29). On the forehead we note a whole series of spots or bands of a very dark brown, almost black. One of these bands extends on each side from the anterior corner of the eye to the base of the upper mandible and another median band divides the forehead from the base of the beak to the crown. The latter is covered with down of three different colors. The base is of a russet brown ('Verona brown', *ibid.*, Pl. 29), the spots are of a very dark brown, almost black, and the tips of the down are dotted with minute whitish points. The throat, breast and belly are covered with a longer, more silky down, almost white in color, faintly tinted with a yellowish buff in the posterior portions. On the throat we note two very peculiar blackish-brown points that are sometimes joined together. The anterior extremities, the flanks and the back are at base of a 'tawny buff' (Ridgway, 1912, Pl. 29), which is almost wholly hidden by dull-black spots, which predominate, especially on the back. Furthermore all these parts are dotted with whitish specks of down. In the dried specimen the beak appears black and the feet olive-gray. Those young in which the scapular feathers and remiges are beginning to grow, are, like those of the Sanderling, much less bright in color than the newly hatched young, as if faded. The under parts have the down of a less pure white, and the gray bases of the down show through. The colors of the upper parts are likewise much less pure, the 'tawny-olive' (Ridgway, 1912, Pl. 29) visibly predominating. Finally, the white tips of the down are partially worn, or rather have changed their color to a 'pinkish buff' and have become less obvious.

42. **Pelidna** (=**Calidris**) **alpina alpina** (Linné).

Pelidna alpina (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 67, 69, 1907.

Tringa alpina Linné. Toll, Die russ. Polarf. d. "Sarja," p. 348, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: adult female, 24 August 1900, Western Taimyr (Dr. Walter); adult male and a second adult, 17 June 1902, adult female, 9 June 1902, adult, 3 June 1902, all from Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff).

The Dunlin inhabits the Eurasian tundra in the breeding season, from Spitzbergen (Sect. I) on the west to the Tas-Khaiakh chain, between the Yana and the Indigirka

Rivers (Sect. XV) on the east (note of Buturlin to Dresser, in Eggs Birds Europe, p. 695, 1910). Evidently its breeding grounds do not extend so far toward the North Pole as those of *Calidris arenaria, Tringa canutus,* and *Ancylochilus subarquatus* or even of *Limonites minuta,* and it is for this reason that the species is altogether wanting in the Franz Josef archipelago (Sect. IX), the northern island of Nova Zembla (Sect. VIII) and the New Siberian archipelago (Sect. XVI); this explains also why it is relatively rare in Spitzbergen (Sect. I), the southern island of Nova Zembla (Sect. VIII) and the Taimyr peninsula (Sect. XII).

The Russian Polar Expedition met with the Dunlin 24 and 27 August 1900 in Middendorff Bay, Western Taimyr (Walter, *l. c., et in litt.;* Birula, *l. c.*). In 1901, Baron Toll was the only one to observe it, a pair 18 July during a journey to the mouth of the Taimyr River some 900 kilometers from the winter-quarters of the "Sarja." Next, in 1902, the auxiliary expedition under Brusneff (*in litt.*) found this species in the vicinity of the Elijdep promontory, Charaulach Mountains, and established its presence at the mouth of the Lena, a doubtful point since the data recovered under this species by Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 54, 1888) refer according to his notes, in part at least to specimens of *Heteropygia maculata* (Vieillot). In order to establish beyond doubt the identification of specimens of the Dunlin brought back by the Russian Polar Expedition, I append the following table of their principal measurements:

Measurements of the Western Dunlin.

Sex	Date	Locality	Collector	Centimeters				
				Culmen	Wing	Tail	Tarsus	Middle toe with claw
♀ ad.	24 Aug. 1900	Western Taimyr	Dr. Walter	3.0	11.2	5.2	2.5	2.2
♂ ad.	17 June 1902	Elijdep promontory, Charaulach Mts.	M. Brusneff	3.2	10.8	5.1	2.6	2.1
Ad.	do	do	do	3.3	11.2	5.1	2.4	2.1
♀ ad.	9 June 1902	do	do	3.8	11.4	5.2	2.7	2.4
Ad.	3 June 1902	Charaulach Mts.	do	3.8	11.5	5.25	2.7	2.2

The measurements given in this table convince me that the specimens from the latitudes of the Charaulach Range and the Elijdep promontory should be regarded as belonging to the typical western form of the Dunlin, *Pelidna alpina alpina* (Linné). Specimens secured by the "Vega" Expedition have been similarly identified by Professor Palmén (Sibir. Ishk. Fogelf., p. 309, 1886), but Schalow (Fauna d. Arkt., p. 197, 1904) states his opinion that they represent the American race with its slightly larger dimensions. For my part, I think that from their measurements the "Vega" specimens are

just intermediate between the two extreme forms, and should convince us that between the smaller specimens from the extreme west and the larger ones on the extreme east there is a complete intergradation in size as well as in coloration and that this species exemplifies the general law that birds of nearly circumpolar distribution undergo an increase in size toward the east. I believe that the "Vega" specimens represent the eastern form of the Dunlin known by the name of *Pelidna alpina sakhalina* (Vieillot).

Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) recorded the arrival of the Dunlin at Yeretiki on the Murman coast (Sect. III) 30 May 1900; Sebaanning (Bergens Mus. Aarb., 1907, no. 8, p. 63) first saw them at Matochkin-shar in Nova Zembla 24 June, placed the date of hatching of the young at 20 July 1903, and noted the last birds 30 August 1902. Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 220, 1853) observed them 16 June 1843 on the Taimyr River (Sect. XII) in latitude 74° north; Pearson (Ibis, 1898, p. 200) tells us that on 8 July he found four half-incubated eggs on Vaigach Island (Sect. VII). Lastly, Middendorff noticed the last individuals in Taimyr (Sect. XII) in latitude 75° 30′ north, 27 August 1843; while Miss Haviland (Ibis, 1915, p. 397) recorded its departure from Golchiha at the mouth of the Yenisei (Sect. XI) on 27 August 1914.

Pelidna (=**Calidris**) **alpina sakhalina** (Vieillot).—*Local name:* in Chukche, *tscharykodlin* (Palmén). I have no doubt whatever that the specimens of Dunlin, brought back by the "Vega" Expedition from the vicinity of Pitlekaj on the north coast of the Chukche peninsula (Sect. XXI), belong to the eastern form. Buturlin (Ibis, 1906, p. 132) personally met with this race in considerable quantity 10–11 June 1905 while crossing the mouth of the Kolyma (Sect. XIX). On the north coast of the Chukche peninsula (Sect. XXI) this species has been recorded independently of the "Vega" (Palmén, Siber. Ishafsk. Fogelf., p. 309, 1887) by Nelson in the Cruise of the Corwin (p. 88, 1883, under *Pelidna alpina americana* Cassin) near Cape Vankarema, and by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 17, 1914) near Cape Serdze-Kamen.

Note.—Bianchi (Ann. Mus Zool. St. Pétersbourg, vol. 7, p. 269, 1902) mentions a specimen of *Limicola platyrhyncha* Temminck (=*falcinellus falcinellus* (Pontoppidan)) brought back to our Zoölogical Museum by the Scientific Expedition for the Exploration of the Murman Coast, killed 3 June 1900 at Waida Bay. The specimen in question turns out to be a Dunlin (*Pelidna alpina alpina* (Linné)).

43. Gallinago (=Capella) ? sp.

On 30 June 1901, at the first winter-quarters of the "Sarja" in Western Taimyr (Sect. XII) Dr. Walter found the egg of a Snipe that can only belong to the Greater Snipe, *Gallinago major* (Gmelin) or to one of the Siberian species of *Gallinago*. But since I am in no wise prepared to admit that the Greater Snipe could have wandered so far from the bounds of the subalpine zone, I presume that in this case we have to do rather with some Siberian species. Unfortunately the oölogical collections of our Zoölogical Museum are quite without sufficient material of Siberian Snipes' eggs to enable the exact identification of the egg in question. It closely resembles a set of eggs brought back by General Przewalski from his expedition into Ussuri Land and determined as

belonging to *Scolopax stenura* Horsford, but I am not at all certain that this identification is correct. The description of this egg follows:

1. One egg, 30 June 1901, west coast of Taimyr Strait (Dr. Walter).—The ground color is a pale olive buff (Ridgway, 1912, Pl. 40), the deeper pale spots are rather numerous and of a smoke gray (*ibid.*, Pl. 46) and the large superficial spots sometimes of an olive brown (*ibid.*, Pl. 40), or sometimes of a blackish brown (*ibid.*, Pl. 45). Dimensions and weight: 49.8 mm. x 33.3 (123 cg.).

Gallinago (=Capella) gallinago gallinago (Linné).—The Common Snipe evidently does not belong to the fauna of the Eurasian tundra and only breeds in the vicinity of its southern limit in those localities where the subalpine zone approaches the coasts of the Arctic Ocean. It is recorded in small numbers from different places on the Murman coast (Sect. III), among others near the village of Yokanskoye by Pearson (Beyond Petsora Eastw., p. 317, 1899) under *Gallinago major*. It is also recorded from the Kanin peninsula (Sect. IV) and by Smirnow (Nature and Hunting, 1903, no. 3, p. 19, in Russian) from the Bolschesemelskaja tundra (Sect. VI).

Gallinago (=Capella) gallinago raddei Buturlin.—The eastern form of the Common Snipe has been recorded by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 135, 1887, under *Scolopax* sp.?) from Bulgunjak at the mouth of the Lena River (Sect. XIV); by the same naturalist (*ibid.*, p. 113, under *Scolopax gallinago*) in the mouth of the Yana, as far as 76° north latitude (Sect. XV); by Zitkow and Sensinow (Journ. Sect. Zoöl. Soc. Friends Nat. Sci. Anthr. and Ethn., new ser., vol. 3, no. 2, p. 9, 1915, under *Scolopax gallinago*) from the mouth of the Indigirka (Sect. XVIII); and finally by Buturlin (in Dresser, Eggs Birds Europe, p. 689, 1910) for the mouth of the Kolyma as far north as 70°. In other words it reaches the shores of the Arctic Ocean.

Scolopax rusticola rusticola Linné.—Remains of the Common Woodcock were found by Professor König (Avif. Spitzb., p. 164, 1911) both in 1907 and in 1908 at Sassen Bay, Spitzbergen (Sect. I) outside the dens of arctic foxes. Probably these birds on leaving the British Isles in their fall migration were misled by the warmer temperature of those parts of the Atlantic where the Gulf Stream flows, and following its eastern branch, reached Spitzbergen where they perished and easily fell a prey to the arctic foxes.

44. **Phalaropus hyperboreus** (Linné) (=**lobatus** (Linné)).

Phalaropus hyperboreus (Linné). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 12, 67, 68, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: Adult female, 18 June 1902, Island of New Siberia (A. Birula); two adult males, 17 June 1902, adult female, 22 June 1902, all from Charaulach Mountains, Elijdep promontory, mouth of the Lena (M. Brusneff).

Local name: in Yakut and Tunguse, in the region of the Yana River, *tscharautschán* (Birula).

The Northern Phalarope inhabits the entire extent of the Eurasian tundra but is quite lacking in the more northern portions, or rather, it breeds there only casually. It becomes everywhere more common where the subalpine zone reaches the shores of the Arctic Ocean or approaches them. In Spitzbergen (Sect. I) it has been found in very small numbers only, but Professor König (Avif. Spitzb., p. 171, 1911) states his opinion that the pair of these birds that he shot 29 and 30 June 1907 at the mouth of the Advent River

might have been breeding there. This Phalarope has not been found on Bear Island (Sect. II), on the northern island of Nova Zembla (Sect. VIII, b), in the Franz Josef archipelago (Sect. IX), or in the region of Bennett Island (Sect. XVII). As to the mainland along the shores of the Eurasian Arctic Ocean, I am convinced that *Phalaropus hyperborcus* (Linné) might be found everywhere as a breeding bird though in varying numbers, notwithstanding that we are quite without data. At the mouth of the Yana (Sect. XV), of the Indigirka (Sect. XVIII), of the Kolyma (Sect. XIX) (Sebddij Strait and Chaun Bay, *fide* Koren, in Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 13, 1914, and Riley, Proc. U. S. Nat. Mus., vol. 54, p. 612, 1918), as well as on the north coast of the Chuckche peninsula (Sect. XXI) it breeds only in limited numbers or is of altogether casual occurrence.

The Russian Polar Expedition did not find the Northern Phalarope in the latitudes of Western Taimyr, where, however, it has been recorded by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 215, 1853) and by Nansen (Collett and Nansen, Norw. North Polar Exp., p. 8, 1899) on Renö Island, in 74° 46′ north latitude. In the New Siberian archipelago, Birula alone succeeded in securing on 18 June 1902, an adult female on the Island of New Siberia. However, the species has been found and collected on Great Ljakoff Island by the Hydrographic Expedition to the Arctic Ocean; while the auxiliary expedition under Brusneff (*in litt. et exempl. coll.*) found this species nesting abundantly on the tundra in the region of the mouth of the Lena (Sect. XIV), on the Elijdep promontory in the Charaulach mountain range.

We have but few data as to the periodic phenomena in the life of the Northern Phalarope. Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) noted its arrival at Yeretiki on the Murman coast (Sect. III) 4 June 1883, 5 June 1884, 8 June 1899, 8 June 1900, and 11 June 1901, and at Alexandrovsk 30 May 1901; while Middendorff (1853) recorded its appearance at Taimyr River (Sect. XII) in 73° 45′ of north latitude by the middle of June.

Sets of fresh eggs were found by Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130, 1903) in the region of the Pasvig River, Murman coast (Sect. III) between 9 and 20 June and in the western parts of that coast about 19 June; while those sets found about 5 July contained eggs either slightly or heavily incubated. In the Yamal peninsula (Sect. X), Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 335, 1912) found eggs in late June and young birds 11 July. Finally the same explorer (Mem. Russ. Geogr. Soc., vol. 41, p. 126, 1904) has recorded young birds already able to fly 27 and 28 July in the Kanin peninsula (Sect. IV).

The Northern Phalarope has been seen on Vaigach Island (Sect. VII) by von Heuglin (Reise n. Nordpolm., vol. 3, p. 123, 1874) in small flocks of from four to eight birds dur-

ing the month of September. The departure of the main body of these Phalaropes from Golchiha at the mouth of the Yenisei (Sect. XI) has been noted by Miss Haviland (Ibis, 1915, p. 397) on 18 August 1914, and the last solitary individuals on 26 August of the same year.

45. **Crymophilus fulicarius** (Linné).[1]

Crymophilus fulicarius. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 238, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 159, 1902. Brusneff, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, pp. 183, 192, 1904. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 4–8, 11–18, 67, 71, 1907.

Phalaropus. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 158–160, 1904; Die russ. Polarf. d. "Sarja", pp. 68, 87, 403, 591, 1909.

List of Specimens from the Russian Polar Expedition.

Skins: immature and a female, 24 August 1900, Western Taimyr (Dr. Walter); adult female, 17 June 1902, Kotelny Island, New Siberian archipelago (Dr. Katin-Jartzeff); immature, 10 August 1902, Island of New Siberia (A. Birula); two adult females, 10 June 1901, Little Ljakoff Island, New Siberian archipelago (O. Cionglinski); immature and a male, 25 August 1901, Camp Michailow, Kotelny Island (O. Cionglinski); three adult females, 19 June 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff); immature male, a female, adult male, adult female, all 1903, Island of New Siberia (M. Brusneff).

In alcohol: adult, 10 June 1902, Island of New Siberia (A. Birula).

Eggs: three, 2 July 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow); three, 30 June 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff).

Local names: in Russian, region of the Yana River, *plavounetz* or more often *petouschok;* from the latter is derived the name in Yakut, *pitouhok* or *pitujök;* again in Yakut, *tschirip;* in Tunguse, *pepálé* (Birula); and in Chuckche, *pekitschedlin* (Palmén).

The Red Phalarope is known from almost all the sections of the Eurasian tundra, but occurs there under conditions not always absolutely alike. In Spitzbergen (Sect. I) it breeds in abundance, on Bear Island (Sect. II) it occurs, but nests there only casually. On the Murman coast (Sect. III) and chiefly in the latitudes of Varanger Fjord, it comes to winter on the coast. From the Kanin peninsula (Sect. IV) and from the regions of the mouth of the Pechora (Sect. VI) data are lacking, while on Kolguev (Sect. V) and Vaigach Islands (Sect. VII) the bird itself has been found but its breeding is uncertain. I cannot refrain from offering the following explanation of these facts: namely, that the Red Phalaropes that come to winter on the Murman coast are probably from Spitzbergen. To the east of the mouth of the White Sea this bird may appear on migration on Kolguev and Vaigach Islands as well as in the more northern parts of the Kanin peninsula and at the mouth of the Pechora, but it is very likely that it passes there only

[1] According to Thayer and Bangs (Proc. New England Zoöl. Club, vol. 5, p. 13, 1914) there are no tangible differences between American and north Siberian specimens of *Crymophilus fulicarius;* for my part I have undertaken a careful comparison of our east Siberian specimens with those from western Siberia and European Russia and have not detected any difference between them, except seasonal changes in the vivacity of coloration and the breadth of the edges of the feathers of the back. For these reasons I prefer to consider this species as a circumpolar bird without subspecies.

in very small numbers for the sole purpose of reaching the southern island of Nova Zembla (Sect. VIII, a) as a breeding ground. The migration routes that lead to those parts of the tundra lying between Yugor Strait (Sect. X) and Eastern Taimyr (Sect. XIII) probably go along the ancient shores of the sea which during the Pleistocène epoch united the Arctic Ocean to the Aralo-Caspian basin. The route leading to the regions of the Kara Sea and the Yamal peninsula (Sect. X) extends, first, along the course of the Volga and its eastern affluents; the route ending in the mouth of the Ob (Sect. X) passes along the valley of that river; while the route to the latitudes of the mouth of the Yenisei (Sect. XI) and Taimyr (Sects. XII and XIII) goes by way of the Yenisei valley. These migration routes therefore leave out those places situated to the westward of the Ural. This hypothesis readily explains the absence of this species from the Kanin peninsula (Sect. IV) and the region of the mouth of the Pechora (Sect. VI) as well as its comparative rarity on Kolguev (Sect. V) and Vaigach (Sect. VII).

Its breeding on the southern island of Nova Zembla (Sect. VIII, a) is proved but for the northern island (Sect. VIII, b) we are quite without data. However, we may assume that it nests on this latter island in as much as it has been found a breeding species in the Franz Josef archipelago (Sect. IX). From Taimyr (Sects. XII and XIII) to the north coast of the Chuckche peninsula (Sect. XXI) the Red Phalarope is common during the breeding season but as a representative of the fauna of the typical and sterile tundra it probably only nests in considerable abundance in those parts of the Siberian coast of the Arctic Ocean where the tundra region is of a certain breadth and has a greater southward extent on the mainland. On the other hand, in places where the tundra is limited to a narrow strip along the border of the Arctic Ocean, it is probably either lacking or nests only in limited numbers, preferring to go farther north and to nest abundantly in the New Siberian archipelago (Sect. XVI), in the De Long group of islands (Sect. XVII) (Bennett, Henriette and Nowopachenny, as well as on Wrangel and Herald Islands (Sect. XX). This species, like *Calidris arenaria*, has retained a breeding colony in the Caspian steppes since the time when the Caspian and the Aral Seas were united with the Arctic Ocean. For Zarudny (Ornith. Fauna of District Orenbourg, App. Mém. Acad. Sci. St. Pétersbourg, vol. 57, no. 1, p. 292, 1888, in Russian) found it breeding in 1883 in the vicinity of Bisch-Kopa (Ural district) and Professor Sushkin (Birds of the Middle Part of the Steppes of Kirghizes, p. 185, 1908, in Russian) saw on 6 June a single bird on the Irgiz River in the Tourgai district.

The Russian Polar Expedition found the Red Phalarope 25 and 26 August 1901 in Minin Bay and between 6 and 11 September in Middendorff Bay, Western Taimyr, in large flocks, then about to depart from high latitudes (Walter, *ll. cc. et in litt.;* Birula, Toll, *ll. cc.*). In 1901 it was not rare in the vicinity of the "Sarja's" first winter-

quarters (Walter, *ll. cc. et in litt.;* Birula, *l.c.*). During the passage of the "Sarja" from Western Taimyr toward Bennett Island, after leaving Cape Cheljuskin, this bird was noted between 6 and 8 September at sea in latitude 78° 1′ 0″ north and longitude 114° 35′ 0″ east of Greenwich in the latitudes of eastern Taimyr and Baron Toll (*l.c.*, p. 403) noted it, 15 September 1901, on passage between Bennett and Kotelny Islands. In the New Siberian archipelago, in addition to the previous records of Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 276 *et seq.*, 1887) on Great Ljakoff Island, the Russian Polar Expedition found the Red Phalarope to be a breeding bird on Kotelny Island, where it was observed in 1902 by Dr. Katin-Jartzeff (*in litt.*) and in 1903 by Naval Lieutenant A. Kolchak (*in litt.*) as well as on Faddejefski Island in 1903 by S. Tolstow (*in litt.*) and on the Island of New Siberia in 1902 by Birula (*l.c.*).

In Dr. Walter's diary I found a note that he had succeeded in discovering two broods of downy young in Western Taimyr; but neither Dr. Walter nor Birula mentions this in their published accounts and I have no doubt that if Dr. Walter's statement were correct, the young birds in question would be found in the collections made by the Expedition. During a personal conversation that I had with Birula on this matter, we agreed that Dr. Walter had probably at first taken the young birds found for Red Phalaropes and had so referred to them in his notes, but later became convinced of an error in the identification and had therefore omitted the notes on these young from his publications.

Concerning the habits of the Red Phalarope on its nesting grounds in the Island of New Siberia, we may borrow the following account from Birula's (*l.c.*) work:

> For a short time after its arrival on the Island of New Siberia, I saw only solitary individuals of *Crymophilus* that stayed in the vicinity of the pools on the tundra; but by 18 June I had found them already in pairs. One pair had evidently selected for a nesting place the elevated shore of Blagoweschenskij, dotted with pools, already free from snow and partly dry, while the more distant parts of the tundra were still covered with a blanket of snow. On the high and dry hills, I noted, among other small birds, chiefly *Arenaria* and *Calcarius*, that had evidently chosen these same hills as nesting sites, a male *Crymophilus fulicarius* of a light color and with a white mark on the belly, that showed uneasiness at my approach, and ran back and forth giving its note, *pit-pit*. The female on the contrary was quite indifferent to my proximity and continued to swim about in a pool, arranging and preening its feathers and seeking for food in the mud. Later on I occasionally, though not often, came upon males of *Crymophilus fulicarius* on the tundra that had undoubtedly left their nests though I was unsuccessful in finding them. However, I doubt not that this bird nests in the Island of New Siberia, perhaps in limited numbers, as shown by the fact that in autumn young Red Phalaropes retaining a certain amount of down on their heads may be found on the seashore and the tundra pools. Moreover Dr. Bunge has established the fact of the Red Phalarope's nesting on Great Ljakoff Island and in 1886 at this place, noted that the females were gathered in flocks after 4 July. At almost the same time, notably 9 July 1902, I noticed on the Island of New Siberia, the first flocks of these birds, consisting of from seven to fifteen females each. All the specimens secured from the flocks at this time were females, very fat, about to start moulting and with their ovaries but slightly enlarged. New feathers were beginning to come in on the fore parts of their necks and on their breasts, although in general they still retained their

bright colors. Simultaneously with the occurrence of these nomadic flocks of female Red Phalaropes, I was able nevertheless to note the presence of pairs still busied near their sets of eggs.

The sand shoal situated near my camp on the shore of Blagowestchenskij Strait was frequented at ebb tide not only by numerous companies of the usual denizens of the tundra, but at times also by rare and probably accidental visitors, such as *Phalaropus hyperboreus* and *Squatarola helvetica*. This sand flat gave me a chance to study rather minutely the final moments of the Red Phalarope's sojourn on the island. From 27 July 1902, on, the day of my arrival at this camp, I found on this sand flat numerous flocks of *Crymophilus fulicarius* in part consisting of birds still wearing their summer plumage, with others in various stages of moult. In the interior of the island after 19 July I noticed flocks of such birds that had nearly completed the change. At a distance these birds appeared gray in color, but when closer at hand a russet tint could be made out on their breasts. During the ebb tide, hundreds of Red Phalaropes frequented the sand flat up till 2 August. They ran about over the mud picking up food in the shape of minute invertebrate animals, or busied themselves in fishing for minute crustaceans in the muddy water at the mouth of the river. During flood tide they sought the pools of the tundra or the muddy shores of streamlets. For a week after 2 August, I saw not a single Phalarope on the sand flat, but only a quantity of young *Tringa canutus* and a rather small number of *Calidris arenaria* and *Arenaria interpres*. On 10 August the flat was once more peopled with flocks of Red Phalaropes consisting chiefly of immature birds which no longer bore down on their heads, although this was still present on the heads of the young *Calidris arenaria* and *Tringa canutus*. About 14 August the weather grew cold, with a temperature throughout the day below 10° centigrade, and the tundra was covered with snow. From time to time a gale arose and the tundra took on an altogether wintry aspect. On 17 August the temperature during the night fell to —3.6° centigrade and the seashore as well as the sand flat at ebb tide was edged with thin ice. Occasionally flocks of shorebirds visited the flat, but after circling about a few times, went back to the tundra. At the end of a week, the weather moderated for a short while, the snow melted and the shores no longer were edged with ice. After 25 August the sand flat was again frequented by small flocks of *Crymophilus fulicarius*, which in dwindling numbers of individuals, remained until 1 September and stayed on the flat only a short while. At this time I could see that these flocks were going out to sea in a southwesterly direction toward the south coast of Faddejefski Island. After 5 September I saw no more shorebirds on the sand flat, so that the Phalarope was the last shorebird to leave the island. The last individual of *Crymophilus fulicarius* was seen on 14 September, going northward. There now came a definite change in the weather, winter set in and by 8 September the air temperature fell to —9.0° centigrade.

To finish the picture of the summer life of the Red Phalarope I must revert to the very interesting phenomenon of its migration from the sea in high latitudes which I several times had occasion to observe in 1901 and 1902 in the course of the Russian Polar Expedition. I have already remarked (above) that numerous flocks of Red Phalaropes appeared 3 September and between 6 and 11 September 1901, during their southward passage in Nordenskiöld Sea, between 77° and 75° north latitude and 113° and 140° east longitude. I likewise noticed on 30 August 1902 an active southward movement of birds that I took to be Red Phalaropes, northeast of the Island of New Siberia in latitude 75° 20′ 0″ north and longitude 157° 45′ 0″ east of Greenwich. Obviously this species inhabits in some abundance the islands to the north of the New Siberian archipelago, that is, the De Long group and particularly Bennett Island, (where it was found by Baron Toll), Henriette and Jeanette Islands and probably some others still unexplored. From this point of view the fact that the "Sarja" met with flocks of *Crymophilus* at sea, to the northeast of Eastern Taimyr, that would reach the nearest points of the mainland during the daylight hours of 3 September 1901, becomes of very special interest. This observation indicates that to the west of the De Long group of islands and much farther to the north there are islands frequented in summer by the Red Phalarope. In 1903, according to a statement of Naval Lieutenant A. Kolchak, great quantities of these birds were passing southward by way of De Long Strait, which indicates the correctness of my supposition that migrating birds met with at this place by the "Sarja" in 1902 were

also *Crymophilus*. I believe that the Red Phalarope leaves all these islands of the Siberian Arctic Ocean, known or partly unknown, in the autumn late in August, over a wide front and does not reach the mainland by special routes. From the New Siberian archipelago, and obviously from the De Long group of islands this species goes in part by way of the Ljakoff Islands and in part directly to the south and southeast. Argentow (Mem. Russ. Geogr. Soc., vol. 1, p. 7, 1861, in Russian) observed flocks of this Phalarope, coming perhaps from the Bear Islands, reaching the mainland at the mouth of the Kolyma.

We have the following data as to the arrival of the Red Phalarope in high latitudes. In Spitzbergen (Sect. I) Walter (Journ. f. Ornith., vol. 38, p. 238, 1890) noted single individuals in Edge Land after 29 May till 2 June, while the bulk of the birds did not arrive till 4 or 5 June. Pike (Chapman, Wild Norway, p. 350, 1897) witnessed the arrival of this bird at Amsterdam Island 3 June 1887. In the latitudes of Western Taimyr (Sect. XII) the first ones appeared, according to Birula, 7 June 1901, but the greater part did not come until 15 June (Walter, *in litt.*), while according to Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 216, 1853) it appeared at the Taimyr River in latitude 73° 45′ north about the middle of June 1843. The first ones arrived in the New Siberian archipelago (Sect. XVI) as noted by Dr. Katin-Jartzeff (*in litt.*) in the environs of Nerpalach, Kotelny Island, on 17 June 1902, and the main body by 19 June 1902. According to S. Tolstow (*in litt.*) the bulk of the birds reached Faddejefski Island by 21 June in 1903, and the Island of New Siberia, according to Birula on 10 June 1902. Finally Buturlin (Ibis, 1906, p. 133) on 10–11 June 1905 witnessed its migration in considerable numbers at the mouth of the Kolyma (Sect. XIX); while on 31 June 1879 it appeared near the winter-quarters of the "Vega" (Palmén, Sibir. Ishk. Fogelf., p. 334, 1887) on the north coast of the Chuckche peninsula (Sect. XXI). After their arrival on their breeding grounds, the Red Phalaropes during their courtship plays, fight furiously with one another. Dr. Walter (*in litt.*) on 20 June 1901 had occasion to watch a scene where a dozen males were paying court to a female and fighting among themselves on the ground in the tundra.

The following data are available as to the time of egg-laying and the moment of hatching in the case of this Phalarope in the different sections of the Eurasian tundra region, but owing to the absence of data as to the length of the incubation period, we are not in a position to draw any conclusions from them. In Spitzbergen (Sect. I) Professor König states (Avif. Spitzb., p. 174, 1911) that egg-laying normally takes place in the last third of June which is quite in accord with the statements of other naturalists. Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 103, 1900) found fresh eggs 27 June, and Münsterhjelm (Oefv. Finsk. Vet.-Soc. Forh., vol. 53, p. 14–15, 1910) in 1910 found two fresh sets, 19 June, of four and three eggs respectively; 21 June, five nests; on 23 June, four fresh eggs; 26 June, four fresh eggs; 28 June, four eggs slightly incubated and four heavily incubated; 29 June, three eggs slightly and three much incubated; and finally, 1 July, two sets

of four fresh eggs each. But in exceptional cases, as in the one cited by Malmgren (Journ. f. Ornith., vol. 13, p. 199, 1865), one may still find fresh eggs at the end of July. At Matochkin-shar, Nova Zembla, Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 67) found on 15 July 1903, a set in which the eggs were on the point of hatching. In Western Taimyr (Sect. XII) Middendorff found perfectly fresh eggs on 29 June and Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, pp. 132, 133, 1887) found others at Sagastyr, at the mouth of the Lena (Sect. XIV), on 2 July and 5 July 1884. In the New Siberian archipelago Dr. Bunge (*l.c.*, p. 279) secured on Great Ljakoff Island, 6 July 1886, four eggs six days incubated, and on 7 July 1886 three others unincubated. The set collected by S. Tolstow presents no striking differences and shows the following measurements and weights.

1. Three eggs, 2 July 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow): 32 mm. x 22.1 (55 eg.); 33.5 x 22.5 (60 eg.); 33 x 22 (58 eg.). I suspect that these eggs are not wholly emptied of their contents and for this reason their weights appear to exceed the normal.

The set secured by Brusneff has the following measurements and weights.

2. Three eggs, incubated, 30 June 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff): 31.2 mm. x 22 (42 eg.); 34.5 x 22 (43 eg.); 35 x 22.7 (47 eg.).

Middendorff found young birds half feathered out 6 August 1843.

The time when the young birds begin to fly was found by Römer and Schaudinn in Spitzbergen (Sect. I) to be 26 July; in Western Taimyr (Sect. XII) by Dr. Walter (*in litt.*) the middle of August; and in Chaun Bay (Sect. XIX) by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 13, 1914) 30 July.

In addition to the detailed account of the autumnal life of these Phalaropes in flocks as given by Birula (above), such flocks were observed 25 August 1900 in Minin Bay by Baron Toll and on 12 August 1901 in Western Taimyr (Sect. XII) by Dr. Walter (*in litt.*)

On the departure of the Red Phalarope from high latitudes we have at hand the following notes. In Spitzbergen (Sect. I) they begin to leave, according to Professor König (1911, p. 177) by the last of August and the last birds probably leave the archipelago in September. Miss Haviland (Ibis, 1915, p. 396) writes that all the Phalaropes had left Golchiha, at the mouth of the Yenisei (Sect. XI) by 5 August 1914. In Western Taimyr (Sect. XII) the last individuals of this species were seen by Dr. Walter (*in litt.*) and Baron Toll (*l.c.*) in Middendorff Bay 11 September 1900. Middendorff noted the departure of the last birds from Taimyr in latitude 75° north on 27 August 1843. In the New Siberian archipelago (Sect. XVI) Dr. Bunge (*l. c.*) noted the departure of the bulk of these birds from Great Ljakoff Island 26 August 1886, and of single individuals between 10 August and 4 September 1886; while the last birds were seen 13 September. In 1903, Naval

Lieutenant Kolchak (*in litt.*) saw immense flocks of Phalaropes about to start on their autumnal migration between 10 and 14 September in the vicinity of Camp Michailow, Kotelny Island. Again, the late Baron Toll on 15 September 1901, saw a flock on migration from Bennett Island (Sect. XVII) in a northwest-southeast direction toward Kotelny Island. At the mouth of the Yana (Sect. XV) Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 113, 1887) noted the last Phalaropes on 19 September 1885, and at the "Vega's" winter-quarters, on the north coast of the Chuckche peninsula (Sect. XXI) the last birds were seen between Pitlekaj and Irgunnuck on 28 September 1878 (Palmén, *l.c.*). The most northerly record is of two Phalaropes killed 10 June 1896, by the crew of the "Fram," 250 kilometers north of Spitzbergen in latitude 83° 1′ north (Collett and Nansen, Norw. North Polar Exp., p. 45, 1899).

GRUIFORMES (=MEGALORNITHIFORMES).

Gruidae (=Megalornithidae).

Grus (=Megalornis) cinerea subsp.?—Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 314, 1908) is authority for the statement that a pair of Cranes once appeared on the shores of the Peschanka River, south island of Nova Zembla (Sect. VIII). It is an open question whether these were the Common Crane, *Grus cinerea cinerea* Bechstein, or the eastern form, *Grus cinerea lilfordi* Sharpe.

? **Grus (=Megalornis) canadensis** Gmelin.—*Local name:* in Chuckche, *ketschanger* (Palmén). During a journey to Koljuchin Bay on the northern coast of the Chuckche peninsula (Sect. XXI), Dr. Almquist, surgeon of the "Vega," saw between 14 and 16 June 1879, a rather large number of Cranes, but did not succeed in securing a specimen. Other members of this expedition, Brusevitz and Boström, likewise saw Cranes during excursions in the vicinity of their vessel's winter-quarters. The species was not certainly identified, but it is probable that the birds seen belonged to the American form (Palmén, Sibir. Ishk. Fogelf., p. 348, 1887). Finally Koren (Thayer and Bangs, Proc. New England Zoöl Club, vol. 5, p. 25, 1914) noted the presence of Cranes 18 July 1912 at Cape Bolschoi Baronowski and on 19 July 1912 at Balagan and at Sebddij Strait.

46. **Sarcogeranus leucogeranus** (Pallas).

Sarcogeranus leucogeranus (Pallas). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 99, 1907.

Local names: in Russian, latitudes of the Yana River, *sterch;* in Yakut, *kytylyk;* in Tunguse, *kïïdok* (Birula).

According to the statements of Dr. Bunge (Beitr. Kemtn. Russ. Reichs, ser. 3, vol. 3, p. 114, 1887), Argentow (Suppl. Journ. Siberia, vol. 1, p. 395, 1876) and Birula (*l.c.*) the White Crane inhabits the coasts of the Arctic Ocean in very limited numbers in the regions of the mouths of the Yana (Sect. XV), the Indigirka (Sect. XVIII) and the Kolyma (Sect. XIX) (see Buturlin, Ven. and Hunting, 1906, p. 29), and does not become commoner except at the southern limit of the forest region. The White Crane appears at the mouths of the Yana, the Omoloi and the Syalach Rivers as well as at Cape Swjatoi Nos every year but in very small numbers. At the mouth of the Yana it nests but very seldom and farther north in the Muksunowka basin, it does not nest at all. Its nests

have been found only to the eastward and in those parts of the tundra more remote from the seacoast. In the latitudes of the mouth of the Kolyma it is a rare bird and according to Argentow (*l.c.*) only a single pair appears yearly.

RALLIFORMES.

Rallidae.

Rallus aquaticus aquaticus Linné.—In the year 1922 appeared a note by S. Johnsen (Naturen, Bergen, 1922, p. 286–287) on the occurrence of this species in Spitzbergen (Sect. I). As this paper is not at my disposal I can give no details of this very interesting event.

COLUMBIFORMES.

Peristeridae.

Turtur (=Streptopelia) turtur turtur (Linné).—The W. Kapustin collection contains a young bird of this species that had wandered to the Murman coast (Sect. III) and was killed 11 October 1920, near Yokanga. This is obviously a case of a lost bird which, having left its native country, perhaps England, had followed the southern branch of the Gulf Stream, doubled the North Cape, and reached the eastern part of the Murman coast near Yokanga.

GALLIFORMES.

Tetraonidae.

Lagopus hyperboreus Sundevall.—Up to the year 1904, *Lagopus hyperboreus* Sundevall was numbered among the endemic species of Spitzbergen (Sect. I). It inhabits this archipelago in very considerable numbers, and retires regularly into the higher parts for the breeding season so that for this reason it is difficult to secure. In the autumn it leaves the uplands and returns to the flat country, sometimes in masses. While wintering in the archipelago, Arnold Pike (Chapman, Wild Norway, p. 347, 1897) found that the Ptarmigans come to Spitzbergen for food, driving tunnels under the snow.

In June 1904 a pair of these Ptarmigan was killed by members of Porter's party, belonging to the Ziegler Polar Expedition, on Algir Island of the Franz Josef archipelago (Sect. IX) (Pearson, Bull. Brit. Ornith. Club, vol. 19, p. 77, 1907; Ibis, 1907, p. 508). When Fiala's report on the Ziegler-Fiala Expedition appeared, we learned that a Ptarmigan was also met with on Rudolph Island in latitude 81° 40′ north. Wishing to learn if the Russian expedition in command of the late Naval Lieutenant Sedow had met with Ptarmigans in the Franz Josef archipelago I communicated with one of the members of that expedition, the naturalist and geographer, W. Wiese, and received the kind reply that he had himself on one occasion seen the bird on Hooker Island, but it flew off at once before he had a chance to shoot it. From Kolguev Island (Sect. V) Fedosow (The Ukrainia Hunter and Fisherman, 1926, no. 7, p. 28–29) informs us that he succeeded in shooting 13 October 1921, at Bugrina River, from a large flock of *Lagopus*, seven specimens. Fedosow himself considered this flock as stragglers from Nova Zembla because during his sojourn at Kolguev he found no trace of the presence of Ptarmigans, whereas Willow Grouse nested in abundance and he regarded the soil conditions there unsuitable for the nesting of Ptarmigans. He was so obliging as to send me a copy of his original diary from which I learned that the birds obtained were in nearly complete winter dress, the males had black lores and the bases of the tail-feathers were white. The last point indicates that the seven birds mentioned were *Lagopus hyperboreus* Sundevall.

In 1921 the officials at the coal mine on Bear Island (Sect. II) told Dr. Langstaff (Ibis, 1924, p. 495) that Ptarmigan only visited the island in winter, coming probably from Spitzbergen. However, Dr. Hoel, of the Norwegian expeditions to Spitzbergen in 1919–21, succeeded in finding Ptarmigans in summer on Mt. Misery, Bear Island, that appear not to differ from those on Spitzbergen, proving that they inhabit the island the year around, though retiring in summer to the summit of Mt. Misery.

In describing the other species of Ptarmigans that inhabit the Eurasian tundra, I may be permitted to express the supposition that if the presence of a Mute Ptarmigan should be established on Nova Zembla (Sect. VIII) I would not be surprised if it turned out to be *Lagopus hyperboreus* Sundevall. This supposition was expressed also by Palmén (Sibir. Ishk. Fogelf., p. 301, 1887) and Jordans (Journ. f. Ornith., vol. 73, p. 449, 1925) states that in his opinion the single Ptarmigan observed, but unfortunately not secured, on Meshdusharskij Island in June 1924, belonged also to *Lagopus hyperboreus* Sundevall.

47. Lagopus lagopus lagopus (Linné).

Lagopus albus (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 9–11, 13–14, 17–19, 21, 1907. Toll, Die russ. Polarf. d. "Sarja," pp. 55, 309, 534, 540, 545, 546, 1909.

Lagopus sp. Kolomeitzeff, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 5, pp. 507, 508, 1902.

Lagopède, Mathiessen, *ibid.*, vol. 20, no. 2, p. 50, 1904. Brusneff, *ibid.*, vol. 20, no. 5, p. 174, 1904.

List of Specimens from the Russian Polar Expedition.

Skins: adult in winter plumage, 10 March 1902, Durnovskaja Bay, vicinity of Nerpalach, Kotelny Island (A. Birula); adult female, 5 September 1902, Island of New Siberia (A. Birula); (male) adult, 21 May 1901, Camp Michailow, Kotelny Island (O. Cionglinski).

Eggs: eleven, 15 June 1902, eleven, 27 June 1902, from Island of New Siberia (A. Birula); eight, 28 June 1903, Derewjannyja Mountains, Island of New Siberia (M. Brusneff); five, 25 June 1903, Roshin promontory, Island of New Siberia (M. Brusneff); eight, 21 June 1903, Faddejefski Island (S. Tolstow); three, 22 July 1903, between the Sogoloch and Nikolskaja Rivers, Kotelny Island (P. Olenin); two (destroyed), 5 July 1902, Nerpalach, Kotelny Island (Dr. Katin-Jartzeff).

Local names: in Samoyede, on Kolguev Island, *houdin* (Trevor-Battye); in Yakut, *chabdi;* in Tunguse-Lamut (in the tundra), *tektschany* (Birula); in the Chuckche tongue, *reoumrou* (Palmén).

The Willow Grouse of Russian Lapland is a typical representative of the fauna of the subalpine zone, where it frequents the marshes covered with clumps of moss and the bushy thickets of willow (*Salix*), birch (*Betula*) and alder (*Alnus*). These types of habitat do not allow it to penetrate regularly so far to the northward as the Mute Ptarmigan, which represents the fauna of the alpine zone. A detailed analysis of the conditions of its geographic distribution along the edge of the Eurasian tundra shows the precision of this limiting factor in general. However, we run against a very serious contradiction in the fact that in some parts of the Eurasian tundra the Willow Grouse in the breeding season goes far beyond the southern limit of the tundra, becoming in these latitudes in part a migratory bird and inhabiting the most elevated sections of the alpine zone covered by an absolutely dwarfed vegetation. Thus, the New Siberian archipelago is inhabited almost exclusively and in great numbers by the Willow Grouse, and very possibly this bird also frequents the islands situated more to the northward, for example some of the islands in the De Long group. The existence of a Willow Grouse with entirely different habits and habitat from the normal, seems to confirm the correctness of the views of Serebrowsky on the one hand and of Thayer and Bangs on the other. The first (Journ. f. Ornith., vol. 74, p. 511, 1926) has recognized as two distinct sub-

species: (1) the Willow Grouse of the Kola peninsula, *Lagopus lagopus kapustini* Serebrowsky, and (2) that of the New Siberian archipelago and the adjacent parts of the Siberian mainland, *Lagopus lagopus birulai* Serebrowsky; whereas the latter authors described the birds of the vicinity of Nishny-Kolymsk (which according to Serebrowsky are the same as those inhabiting the greater part of northern Siberia) as *Lagopus lagopus koreni* Thayer and Bangs (Proc. New England Zoöl. Club, vol. 5, p. 4, 1914).

The Willow Grouse is absent from the islands of the Spitzbergen archipelago (Sect. I) and from Bear Island (Sect. II). In Russian Lapland (Sect. III) it inhabits the subalpine zone in very great numbers and at times reaches the neighboring parts of the arctic coasts in places where the region of bush growth extends to their borders. Under similar conditions it also inhabits the Kanin peninsula (Sect. IV), the Malosemelskaja and Bolschesemelskaja tundra (Sect. VI) and the Yamal peninsula (Sect. X). It is fairly abundant on Kolguev Island (Sect. V) but is quite absent from the Franz Josef archipelago (Sect. IX) where it is replaced by *Lagopus hyperboreus* Sundevall. Data relating to Vaigach Island (Sect. VII) are rather contradictory. Buturlin (Our Hunting, 1908, no. 8, p. 49–64, in Russian) and Pearson (Ibis, 1898, p. 205) assert the complete absence of any Grouse or Ptarmigan whatsoever from Vaigach Island. Nossilow (Our Hunting, 1908, no. 8, p. 48, in Russian) claims that a Grouse formerly inhabited the island but has been exterminated by arctic foxes (*Alopex lagopus*); in the same journal and the same year (no. 10, p. 90) this author insists that the Grouse is present there but is rare. I think that this island may rather be inhabited, regularly and in small numbers, by one of the forms of the Mute Ptarmigan but that the Willow Grouse during its migrations sometimes occurs on Vaigach Island. The question as to the presence of some species of Grouse and Ptarmigan on Vaigach Island (Sect. VII) and on Nova Zembla (Sect. VIII) has acquired a special interest through the obdurate discussion between Buturlin and Nossilow on this subject. Certain of the explorers of Nova Zembla admit, often without reserve, the possibility of the occurrence in this archipelago, of Grouse and Ptarmigans and even cite the exact dates when these birds were found. Other authors, on the contrary, absolutely deny that any Grouse or Ptarmigan occurs in Nova Zembla. In order to elucidate this question, it seems best to reproduce verbally the more important opinions and statements of both sides and then to state the opinion that I have myself formed on the subject. The Grouse or Ptarmigan (without indication of the species) is given as an inhabitant of Nova Zembla in the works of the following explorers and compilers who, however, did not make a special study of the ornithology of this double isle: (1) the Captain of Marine Lütke I (Mem. Dept. Admir., vol. 7, p. 74, 1824, in Russian) with reservation; (2) Swenske (La Nouvelle Zemble, p. 105–106, 1866); (3) Spörer (Peterm. Geogr. Mitth., 1867, Erganzungsh. 21, p. 98); (4) Dr. Theel (Oefv. Kongl. Vet.-

Akad. Förh., 1876, no. 5, p. 51) with reservation; (5) Dr. Toeppen (Die Doppelinsel Novaja Zemlja, p. 110, 1879); (6) Ostrowski (Guidebook for Northern Russia, p. 119, 1899).

Another lot of writers are more precise in their statements and affirm that it is the Mute Ptarmigan, *Lagopus mutus* (Montin), that is found in Nova Zembla. Among these authors I may cite: (7) Prince Uchtomski (Nova Zembla, 1883—in Russian); (8) Kriwosheja (Nature and Hunting, 1884, no. 10, p. 49—in Russian), who tells that according to the accounts of the Samoyedes, there occurs in the more elevated portions a Ptarmigan (*Lagopus alpinus*) of a medium size in comparison with that of the tundra.

The third category consists of specialists in ornithology or of travelers who have made a study of the avifauna of the archipelago and have brought back ornithological collections. Among these: (9) von Heuglin (Reisen n. d. Nordpolarm., vol. 3, p. 104, 1874; Ibis, 1872, p. 62) found near the mouth of the Chirakina River in the Matochkin-shar, several Ptarmigan feathers and states that a Norwegian in their company, who knew these birds well, declared that he had seen a "Ripa" (*i.e.* a Ptarmigan) in Dolphin Bay (probably Belushja-Guba?); (10) Smirnow (Nature and Hunting, 1903, no. 5, p. 20, in Russian) tells us that the well-known oölogist Goebel found two broods of Ptarmigans the young of which were of about half the size of the old birds, on 5 August and 9 August 1879, at a distance of from 6 to 9 kilometers from Malijy Karmakuly. The parent birds behaved exactly like those of *L. mutus;* the young birds, according to Goebel, were of a lighter tint than *L. mutus* of the Murman coast. (11) Bilkiewicz (App. Mem. Sci. Exp. Univ. Kasan, p. 20, 1904) lists *Lagopus mutus* Montin, and tells us that he did not himself meet with this species, but that a Samoyede who for several years had lived on the seashore near Kara Strait, had told him that Ptarmigans sometimes arrive in a flight on the coasts of Nova Zembla, coming from Vaigach Island, that they lived there in some numbers, but that this was in summer only, while in winter they were never seen there. (12) Nossilow (Our Hunting, 1908, no. 8, p. 47, in Russian) assures us that

in the first instance I saw a single individual of the Mute Ptarmigan, 7 May 1888, on the banks of the Sawina River (shores of the Kara Sea). In the second case I heard of it on Meshdusharski Island where its appearance seemed to be spontaneous. During the month of May of the same spring, I saw the Mute Ptarmigan in the Kostin-shar; I did not succeed in killing the bird but I identified it by its voice. Later on, I several times met with the same species of Ptarmigan on the upper course of the Sochanicha River (in latitude 72° north), where according to my guides it is common. I learned from the fishermen that in times past the Ptarmigan inhabited the region of Matochkin-shar, but that it has disappeared from there now, probably because of the considerable numbers of arctic foxes in those parts.

The same author in another article (Our Hunting, 1908, no. 6, p. 62–63, in Russian) states his opinion that the Ptarmigan does not occur in the usual wintering places of the Samoyedes in Nova Zembla and for this reason our ornithologists have fallen into error

in these latter times. Again, (13) Madame Dmitrijewa-Sulima, a well-known Russian sportswoman (Our Hunting, 1909, no. 11, p. 91, in Russian) states that the Zyrans and Samoyedes of the Pechora told her that the Mute Ptarmigan inhabits Nova Zembla the year around but in limited numbers and that the Willow Grouse every spring leaves the Bolchesemelskaja tundra, sometimes reaching Nova Zembla where it spends the summer and a part remain for the winter. This migration takes place in very variable numbers, at times large, while again for a series of years the bird may be altogether absent from the north-central parts of Nova Zembla, though found every year in the southern portions. Finally, (14) Jordans (Journ. f. Ornith., vol. 73, p. 449, 1925) observed a Ptarmigan 22 June 1924 on Meshdusharski Island which, although he did not succeed in shooting the bird, he thought it possible to determine as *Lagopus mutus hyperboreus*.

Those writers who deny the existence of any sort of Ptarmigan in Nova Zembla are: Pearson (Bull. Brit. Ornith. Club, vol. 19, p. 77, 1907), Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 314, 1908; Mess. Ornith., 1911, no. 2, p. 110) and with great insistence Buturlin (Our Hunting, 1908, no. 2, p. 123; no. 6, p. 64–68; no. 8, p. 49–64; no. 10, p. 92–97; 1909, no. 12, p. 117, in Russian). None of these explorers of the avifauna of Nova Zembla has found any evidence of the presence of Grouse or Ptarmigan in this archipelago. Molchanow, moreover, cites the negative statements in regard to Grouse or Ptarmigan made to him by the Samoyedes who lived in the more southerly parts of Nova Zembla. Buturlin tells us that neither the Samoyedes nor Vinogradow who spent ten years on Nova Zembla, ever saw a Grouse or Ptarmigan there. Finally Bykow (Our Hunting, 1909, no. 11, p. 93–95, in Russian) who listed the Ptarmigan in his first memoir on this archipelago, later reversed his opinion and states that he has found no evidence of its presence in searching about the dens of the arctic foxes; that the Samoyedes of Malijy Karmakuly, the Belushja Guba and of Matochkin-shar deny its presence; and that Morosow's expedition, which worked between Malijy Karmakuly and the Belushja Guba found no evidence of it either.

Before summarizing these contradictory opinions I must refer to the very interesting point of view expressed by Professor J. A. Palmén of Helsingfors. In his celebrated work on the birds brought back by A. E. Nordenskiöld from his voyage around Asia on board the "Vega" (Palmén, Sibir. Ishk. Fogelf., p. 301, 1887), he expresses the view that *Lagopus rupestris* (Gmelin), because of the immense extent of its geographic range, should be regarded as the oldest species. He supposes that from it are derived the forms that inhabit on the one hand the Alps of Europe, the Scandinavian region, the mainland and the Siberian Alps; and on the other hand a number of islands in the Arctic Ocean where they have undergone differentiation into a certain number of insular races, as for

example the Ptarmigan of Spitzbergen (and also, according to recent investigations, those of the Franz Josef archipelago and Bear Island), *L. hyperboreus* Sundevall; of Unalaska, *L. nelsoni* Stejneger; of some of the western Aleutian Islands, *L. atkhensis* Turner. From this point of view, Palmén even introduces, with reservation, *Lagopus rupestris* (Gmelin) with the Mute Ptarmigan (*Lagopus mutus* Montin) into the list of birds of Nova Zembla (tab. 3). This theory which at first sight seems unlikely and quite without any solid foundation, gains probability since from a study of the collections of our Zoölogical Museum I have lately shown that all the Mute Ptarmigans of the northern Ural, brought back in part by Hoffmann's expedition (Brandt, Wirbelth. nördl. Ural, vol. 2, app., p. 68, 1856) and in part by the Kusnetzow brothers' expedition under the direction of Backlund, and collected by Wardropper, 18 and 25 July 1909 near Minissei Mountain, 17 August 1909 near Lake Osovei, and 21 August 1909 at Tumba-jaga, should be referred to *Lagopus rupestris* (Gmelin). These regions of the Ural situated opposite Vaigach Island can only be regarded as a continuation of the mountains which extend all along the two islands of Nova Zembla in a north-and-south direction and it is very likely that if a Ptarmigan of the *Lagopus mutus* type should be found to occur in Nova Zembla, it will be determined as *Lagopus rupestris* (Gmelin).

I have convinced myself that the Eurasian Ptarmigans, except the *Lagopus hyperboreus* Sundevall of Spitzbergen, Bear Island and the Franz Josef archipelago, represent two distinct species or groups of subspecies: (1) the *Lagopus mutus* Montin group and (2) the *Lagopus rupestris* Gmelin group. The first of these inhabits Norway, Russian Lapland, the Alps of Switzerland, the Pyrenees and Scotland, it was recently found in great abundance on the alpine summits of the Ural Mountains, and, finally, inhabits the summits of the northern Asiatic ranges to Kamchatka and Japan. This form is characterized by its grayer tints in European specimens and its browner tints in its Asiatic representatives beginning with the Ural and ending with Japan. On the other hand the second group, characterized by its russet tints, inhabits in the Eurasian continent only the strip of tundra on the Siberian coast along the Arctic Ocean, beginning with the Pai-choi range (northern part of the Ural) in Europe, the mouth of the Yenisei, the Taimyr peninsula and certain parts of arctic America and Iceland.

While studying the literature of the arctic countries in the Eurasian region, it occurred to me to formulate the theory, rather hazardous to be sure, that Nova Zembla is inhabited not by an insular form of Ptarmigan hitherto unknown, but, it may be, by *Lagopus hyperboreus* Sundevall, recently found in the Franz Josef archipelago. This hypothesis finds a certain substantiation in the observations of Goebel, according to which the young Ptarmigans from the vicinity of Malijy Karmakuly may be distinguished from the Mute Ptarmigans of the Murman coast by their paler tints. More recently Jordans (Journ. f.

Ornith., vol. 73, p. 449, 1925) referred a Ptarmigan seen but not killed, 22 June 1924 on Meshdusharski Island to *Lagopus mutus hyperboreus* Sundevall, and Fedosow's (1926) seven specimens from Kolguev had white bases to the tail-feathers. If future observations give support to my hypothetical suppositions it will be necessary to concede that *Lagopus hyperboreus* Sundevall may inhabit chiefly the elevated and rocky parts of the northern island, whence, as in Spitzbergen, it spreads to the central and perhaps even the southern portions of the archipelago during the winter season. In case my theory is confirmed by future exploration, the rarity of the Ptarmigan in summer in the central and southern parts of the archipelago will be readily explained; explorers but rarely penetrate the rocky interior of the northern island and it is just there that one must look in summer for the Ptarmigan if Nova Zembla is in reality inhabited by the Spitzbergen form. I have endeavored to secure evidence as to the presence or absence of the Ptarmigan in the north island of Nova Zembla and have consulted in this matter Mr. Wiese, the geographer of Lieutenant Sedow's expedition. He has kindly informed me that during their stay from September 1912 to September 1913 on the Pankratjeff peninsula, in latitude 76° north and longitude 60° east, no one in the expedition succeeded in finding any evidence of the presence of a Ptarmigan either at their winter-quarters or in the surrounding regions visited during their excursions. Nevertheless he had no opportunity to obtain any information from natives since these regions are situated much farther to the northward than the last settlements of the Samoyedes.

As to the contradictory opinions on the presence or complete absence of some sort of Grouse or Ptarmigan in Nova Zembla, I chiefly favor the supposition of Mme. Dmitrijeva-Sulima. I think that Nova Zembla is inhabited by a sedentary race, perhaps rare, and that this might be a form of *Lagopus rupestris* (Gmelin) or perhaps of *Lagopus mutus* Montin or even of *Lagopus hyperboreus* Sundevall type. But I surmise further that the southern parts of Nova Zembla especially are visited, perhaps not altogether regularly, by the Willow Grouse, *Lagopus lagopus lagopus* (Linné). In years of severe winters and abundant snowfall the Ptarmigan migrate southward to the coasts of the Arctic Ocean and in spring do not return to high latitudes but settle down to breed farther south. On the other hand, in mild winters they do not go far from the arctic seacoasts and then their spring migrations take them farther north and probably result in their passing Vaigach Island and reaching the southern portions of Nova Zembla.

At the mouth of the Yenisei (Sect. XI) the Willow Grouse was found by the Russian Polar Expedition (Walter, *l. c., et in litt.;* Birula, *l. c.*) on Kuzkin Island opposite Dickson Bay in latitude 73° 30′ north. In Western Taimyr (Sect. XII) the Expedition did not meet with this species, which confirms older statements of Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 190, 1853) that its range does not go beyond 72° 30′ north latitude in Taimyr,

or on account of the error in determination of the latitude found by Birula (1907, p. 21) 73° or 73° 30′ north. The notes of Professor Nansen (Collett and Nansen, Norw. North Polar Exp., p. 7, 1899) as to the occurrence of Ptarmigan on Renö Island (of the group of Kjellman Islands in latitude 74° 46′ north) and in Toll Bay, of the Cheljuskin peninsula were made at long distances and very probably relate to some one of the Mute Ptarmigan group. At the mouths of the rivers Lena (Sect. XIV), Yana (Sect. XV), Indigirka (Sect. XVIII) and Kolyma (Sect. XIX), as well as on the north coast of the Chuckche peninsula (Sect. XXI) the Willow Grouse is found to the shores of the Arctic Ocean. It was noted in abundance on all the islands of the New Siberian archipelago (Sect. XVI) as we shall see in reviewing the detailed notes gathered by the Russian Polar Expedition; and Birula (1907, p. 23) tells us that Brusneff feels certain that the migrations of the Ptarmigan extend northward beyond the New Siberian archipelago. In the course of his journey, this member of the Expedition travelled from Cape Wysokij of New Siberia a distance of some thirty kilometers to the north-northeast and everywhere on the way found traces of Ptarmigan, and during one of his halts, succeeded in killing a pair of these birds on the ice. One may therefore suppose that at times, probably during severe winters, when De Long Strait is covered with ice, Grouse frequent Bennett Island (Sect. XVII) which would confirm the observations of Captain De Long (Voy. Jeanette, p. 635, 1897) who believed he had found evidence of the presence of Grouse on this island.

The first Willow Grouse were met with by the Russian Polar Expedition 13 August 1900, on Kuzkin Island opposite Dickson Bay, at the mouth of the Yenisei. These were a female with young still very small. Throughout the stay of the Expedition in Western Taimyr, this bird was not found, nor was it again met with except in the group of islands belonging to the New Siberian archipelago, all of which it inhabits. It occurs also on the Ljakoff Islands: on Great Ljakoff, found first by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 273, 1887) and later in abundance on 26 May 1903 by Naval Lieutenant Kolchak (*in litt.*), and on Little Ljakoff by Dr. Bunge (*l. c.*) and by Kolchak, 31 May 1903; next by the Hydrographic Expedition to the Arctic Ocean (specimen in our Zoölogical Museum). It was also observed in various places by members of the Russian Polar Expedition in crossing from the mainland to the different islands of the New Siberian archipelago. Thus Birula (1907, p. 23) saw old signs in early December between the New Siberian group of islands (properly so called) and the Ljakoff Islands; Baron Toll (1909, p. 540) met with single birds between Great Simovje and the mainland 30 March 1902, and on 26 March near Little Simovje of Great Ljakoff; Brusneff (*l. c.*), during his journey from the mainland to the Island of New Siberia between 24 February and 24 March 1903, noted this species in considerable numbers, as did also

Naval Lieutenant Matiessen on 28 April and Birula on 11 May not far from the south coast of Kotelny Island. Finally Quartermaster Tolstow (*in litt.*) on 16 and 17 March 1903 noted flocks of Grouse during the entire course of his crossing from Little Ljakoff to Kotelny Island. For the three islands composing the Near group, we have the following notes: on Semenowski Island the crew of the ill-fated "Jeanette" saw Grouse 10 September (De Long, Voy. Jeanette, p. 745, 1897); on Stolbowoi Island Baron Toll (1909, p. 545–546) saw four Grouse 3 April 1902; finally on Wassiljefski Island the Hydrographic Expedition to the Arctic Ocean also noted this bird (specimen in our Zoöl. Mus.). The Grouse is likewise known on all the islands of the Farther group: thus on the northeast point of Bielkovski Island, Naval Lieutenant Kolchak (*in litt.*) saw one on 22 May 1903. On Kotelny Island this bird was found in various places: near the second winter-quarters of the "Sarja" in Nerpalach Bay by Dr. Katin-Jartzeff (*in litt.*), Matiesen and Kolchak during their journey on 25 June 1902 to the Ogrin promontory; and on 24 July 1902 on the Chukotskaja River by Dr. Katin-Jartzeff, and again on 3–8 June 1902 by Kolchak (*in litt.*) near the Balyktach River. During the auxiliary expedition of 1903 Naval Lieutenant Kolchak (*in litt.*) saw the species at Cape Medweshi and on 2 October in large numbers near Camp Michailow; finally Quartermaster Tolstow on his arrival at Kotelny Island in 1903 found the Grouse there already in abundance. On Faddejefski Island, Lieutenant Kolchak (*in litt.*) came upon considerable numbers of Grouse 12 June 1902, as did also Tolstow in 1903, who even succeeded in finding on 25 June a nest with ten eggs. Lastly, Birula (1907) met with the Grouse in some abundance during his stay on the Island of New Siberia in 1902.

A peculiar characteristic of the Willow Grouse of the Eurasian tundra is its migrations. In the discussion of opinions as to the presence or absence of this bird in Nova Zembla, and on Vaigach Island, we have already mentioned that the Grouse leave the latitudes of the eastern parts of the European tundra for the winter and according to the severity of the season go to countries more or less distant from their breeding places. The same thing has been noted by Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 330, 1912) for the Yamal peninsula; this naturalist tells us that the Ptarmigan does not winter in the Pjasidai river system. The results published by Birula (1907, p. 22) show us that according to the observations of the members of the Russian Polar Expedition, most of the Willow Grouse in reality leave the islands of the New Siberian archipelago in autumn for the mainland though a certain number remain to pass the winter. According to native reports, the Grouse, like the reindeer, gather in the months of October to December on the south coast of Kotelny Island. There they remain for some while, awaiting the time when the sea shall be covered with ice, for they will not risk crossing the open sea of the strait which here is 120 kilometers wide. When the open spaces

and the rifts are quite covered with ice, the flocks of birds, one after the other, begin to leave the island. They make the crossing in stages, resting now and then upon the ice. At this time one may often find either the tracks of flocks that have stopped on the way, or the birds themselves. I have already referred (above) to a number of such cases noted by members of the Russian Polar Expedition during their sledge journeys between the Siberian mainland and the islands of the New Siberian archipelago.

As to the manner in which those Ptarmigan that remain to winter in New Siberia procure their food, the observations of Birula (1907, p. 24) prove that these birds find in winter, too, a sufficient supply of food and have a layer of fat under the skin. Their crops are entirely filled with young shoots and buds of *Salix polaris*, seed capsules of *Papaver nudicaule* and of a *Stellaria*, together with a medium amount of small leaves of the *Potentilla intermedia* and seed capsules of *Saxifraga caespitosa*. In order to reach this food, the Grouse profit by the reindeer that dig away the snow with their hoofs. On approaching the reindeer one may frequently see the Grouse who keep between the reindeer's feet and scratch the ground in places where the deer have dug through the snow. But the seed capsules of the arctic poppies, *Stellariae*, and the different species of *Saxifraga* are quite accessible to the Grouse even without this help, for all these plants grow chiefly on the slopes of hills which the winds in winter sweep clear of snow in the first place. Life on the tundra of the polar islands is difficult enough for the Grouse, and in order to gain shelter from the violent gales they will bury themselves in thick snow banks during bad weather. I surmise that the tunnels found under the snow by Pike (Chapman, Wild Norway, p. 347, 1897) in Spitzbergen were merely the refuges of Ptarmigan during bad weather, and that these birds obtain their food there during the winter in the same manner as Birula describes.

Regarding the spring moult of the Grouse we find in Birula's paper the following notes: The males very early begin to moult the feathers of the head and neck, while they are still in flocks; the moult of the females commences much later and is completed in a shorter space of time. In the middle of May the females begin to shed their winter plumage; by the latter part of the month their backs are already dark and the feathers of the summer plumage appear on the breast and flanks. In a female killed 1 June, the entire back was dotted with dark feathers while on the dark head and neck there remained but a few white feathers. About 11 June the moult of the females was almost completed, and even the white belly was covered with dark feathers. In the males, on the other hand, after the head and neck change plumage the progress of the moult is interrupted for some while and they remain for a rather long time entirely white with the neck and head of a blackish red. Not until 27 June did Birula observe the appearance of dark feathers on the back of males.

Birula (*l.c.*) tells us that after the polar night of 1901–02, the first Grouse were noted 10 February 1902, in the neighborhood of the second winter-quarters in Nerpalach Bay, Kotelny Island. These were evidently birds that had wintered on the island. Observations by the members of the Expedition on Grouse found during the spring migration between the mainland and the New Siberian archipelago date chiefly from the months of March and early April. According to Buturlin (Ibis, 1906, p. 132) birds did not arrive at the mouth of the Kolyma (where, however, they winter to some extent) until after the middle of May.

Birula noted them in pairs on 16 May and found that egg-laying commenced in late May as shown by the fact that a complete set of eleven fresh eggs was found by him, 15 June 1902, on the Island of New Siberia. On almost the same date, 17 June, Trevor-Battye (Icebound on Kolguev, p. 430, 1895) found a set of twelve eggs on Kolguev Island, while Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 131, 1887) discovered at Sagastyr, mouth of the Lena, on 27 June 1884, an incomplete set of six eggs and on 8 July 1884 a set of eleven eggs containing embryos already covered with down (*ibid.*, p. 134). Zitkow (*l.c.*) in mid-July noted young in down on the Yamal peninsula and Trevor-Battye (*l.c.*) saw on Kolguev Island young birds almost as large as their parents on 14 August.

The Russian Polar Expedition brought back in all six more or less nearly complete sets of Willow Grouse's eggs, that form the basis of the following notes.

1. Eleven eggs, 15 June 1902, Island of New Siberia (*A. Birula*).—the Willow Grouse selects as a nesting site some sufficiently dry spot free from snow and covered rather densely with longer grass of the previous year. It hollows out in the upper layer of sod an oblong shallow depression and there deposits its eggs. The nest shown (Pl. 25, fig. 2) was some 20 cm. long by 18 cm. wide, and was lined with a small quantity of lichens (*Thamnolia vermicularis*) and a certain amount of the bird's own down.

Ten eggs of this set have the ground color of a light ochraceous buff (Ridgway, 1912, Pl. 15), while the eleventh is nearly clay color (*ibid.*, Pl. 29). The large superficial black spots are numerous and are distributed over the entire surface. The dimensions and weights are: 45 mm. x 31 (193 eg.); 47 x 31.2 (182 eg.); 46.5 x 31 (188 eg.); 46.7 x 31.2 (182 eg.); 47 x 31.1 (185 eg.); 47 x 32 (183 eg.); 45 x 31.1 (185 eg.); 47 x 31.2 (188 eg.); 46.7 x 31 (180 eg.); 49 x 31.7 (180 eg.); 47.1 x 31 (183 eg.).

2. Eleven eggs, 27 June 1902, Island of New Siberia (*A. Birula*).—The nest of this set was 23 cm. long by 18 cm. wide, with a depth of 7 to 10 cm.; the lining was the same as in the preceding nest. The eggs of this set are of a light buff (Ridgway, 1912, Pl. 15) in tint and the black spots are large and close together. The measurements follow (the weights could not be determined on account of their insufficient preparation): 43.1 mm.

x 30.1; 42.1 x 31; 43.5 x 31; 44 x 31; 43.3 x 30.4; 42.6 x 31; 43 x 31; 43.3 x 30.8; 43 x 31; 42.6 x 31.7; 44.2 x 31.1.

3. Eight eggs, incubated, 28 June 1903, Derewjannyja Mountains, Island of New Siberia (*M. Brusneff*).—The nest was situated on a projection of a perpendicular cliff on the edge of the sea and had no lining. The ground color of the eggs is of a light buff (Ridgway, 1912, Pl. 15), and the black superficial spots are numerous and close together, distributed over the entire surface of the eggs. Their measurements and weights are: 45 mm. x 32 (195 cg.); 46.5 x 31.6 (191 cg.); 45 x 32 (208 cg.); 45 x 31.5 (207 cg.); 46 x 32 (199 cg.); 46 x 31.4 (196 cg.); 45 x 31.5 (198 cg.); 47.8 x 31 (195 cg.).

4. Five fresh eggs, 25 June 1903, Roshin promontory, Island of New Siberia (*M. Brusneff*). —The nest was lined with dried grass. The ground color of three of these eggs is darker (warm buff, Ridgway, 1912, Pl. 15) and of the two others more russet—a pale ochraceous buff. The superficial black spots are large and numerous. Dimensions and weights: 42.2 mm. x 32.2 (207 cg.); 43.1 x 32.1 (203 cg.); 44 x 32.3 (212 cg.); 44 x 32.1 (206 cg.); 43.1 x 32 (207 cg.).

5. Eight eggs, 21 June 1903, Faddejefski Island (*S. Tolstow*).—The eggs of this set agree in color with those of set 3. Dimensions and weights: 44.1 mm. x 31.1 (206 cg.); 43 x 30 (185 cg.); 44 x 31.1 (227 cg.); 42.8 x 31 (186 cg.); 43.5 x 31 (184 cg.); 44.5 x 31.1 (200 cg.); 44.1 x 31.1 (192 cg.); 45.2 x 31.1 (205 cg.).

6. Three eggs, 22 July 1903, between the Sogoloch and Nikolskaja Rivers, Kotelny Island (*P. Olenin*).—The eggs of this set are obviously different from all the eggs of the other sets in their very fine black spots and smaller dimensions. The ground color is of a light buff (Ridgway, 1912, Pl. 15). Measurements: 41.1 mm. x 31; 41 x 31; 41.6 x 31.

The last Willow Grouse were seen by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 283, 1887) on 1 November 1886 on Great Ljakoff Island and by Birula on 11 October 1901 at Nerpalach, Kotelny Island, where, however, they have also been seen later.

Lagopus mutus mutus Montin.—Within the limits of the Eurasian tundra the typical Mute Ptarmigan is a characteristic inhabitant of the alpine zone, sometimes on the mountain-tops bare of bushes (the *fjells* of Norway and the *tunturi* of Lapland), sometimes in the tundra along the Murman coast on the level of the Arctic Ocean (Sect. III). These birds live in a habitat so completely barren of sufficient vegetation to give them shelter that they can only escape being seen by their enemies through imitating to perfection the coloring of the broken and lichen-covered rocks among which they live. As to the typical Mute Ptarmigans, I presume that they chiefly imitate the rocks containing a considerable amount of hornblende (amphibole). At least among the adult males in breeding plumage from Norway the black coloring predominates; from Russian Lapland I have been able to examine but a single bird in this plumage (in the collection of B. Kapustin), but I presume that the Mute Ptarmigan from there does not represent a distinct subspecies.

For the Kanin Peninsula (Sect. IV) we have at hand only the vague testimony of the brothers Aubel (Ein Polarsommer, p. 241, no. 5, 1874) and there are no means of identifying the form that occurs there.

On Kolguev (Sect. V), Fedosow (The Ukraina Hunter and Fisherman, 1926, nos. 6, 7, 8–9, in Russian) found, 13 October 1921, a flock of nearly thirty Ptarmigans, of which he and his companion had the luck to secure seven specimens in the neighborhood of the Bugrina River. In the opinion of the author these Ptarmigans were undoubtedly stragglers from Nova Zembla, because during the summer no traces of Ptarmigans or their nests were found and he regards the conditions quite unfavorable for their nesting on that island. Much interested in this communication, I addressed a letter to the author and asked him to send me, if possible, the skins of the specimens secured for the exact identification of the subspecies of these birds. The author very kindly replied instantly that the skins, deposited in an obscure school, had already perished, and he is now only in the possession of his diary, from which he kindly gave me the following information. In the middle of October the Ptarmigans were in the winter dress, nearly quite white, the males with black lores; the bases of their tail-feathers were white to a relatively great extent; they had the following dimensions: male, total length, 398 mm.; wing, 225; tail, 122; female, total length, 363; wing, 208; tail, 114. These dimensions are decidedly larger than those of the typical Mute Ptarmigans but smaller than those of *Lagopus hyperboreus* Sundevall with which they have in common the white base of the tail-feathers. An exact identification of the Kolguev Ptarmigans is therefore quite excluded and the question which subspecies of the Ptarmigan inhabits that island remains open.

In the latitudes of the mouth of the Pechora (the Bolshezemelskaja tundra) (Sect. VI) the Ptarmigan seems to be absent on the flat tundra, for according to the statement of Madame Dmitriewa-Sulima (Our Hunting, 1909, no. 11, p. 91–93, in Russian) a single individual was taken there by the natives in 1909 as an exceptionally rare occurrence. The Russian Polar Expedition visited places where the typical form of the Mute Ptarmigan could not be found.

48. Lagopus rupestris (Gmelin).

(Plate 38).

Lagopus mutus (Montin). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2–5, **33**, 1907. Toll, Die russ. Polarf. d. "Sarja," p. 158, 1909.

Schneehuhn. Toll, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 196, 1902.

Lagopus sp.? Kolomeitzeff, *ibid.*, p. 507–508, 1902.

List of Specimens from the Russian Polar Expedition.

Skins: two adult males, autumnal dress, 15 September 1900, Middendorff Bay (Dr. Walter); two adult males, winter plumage, 7 June 1901, west coast of Taimyr Strait (Dr. Walter); adult, winter plumage, 10 June 1902, Elijdep promontory, mouth of the Lena (M. Brusneff).

Local names: in Russian, Yana River region, *malaja kuropatka;* in Yakut, *charkyrer;* in Tungusc, *abeitschan* (Birula).

The Ptarmigans of the Kanin peninsula (Sect. IV), of the island of Kolguev (Sect. V), as also the unique specimen from the Bolshezemelskaja tundra (Sect. VI) are unknown to me, but those of the northern Ural (Sect. VI) brought back by the Ural Expedition of Hoffmann (specimens in the Museum) as well as those secured by J. Wardropper of the Kusnetzow Brothers' Expedition (specimens in the Museum) are unquestionably referable to *Lagopus rupestris* (Gmelin). They are characterized by the very russet tints of both sexes and agree perfectly with birds collected by E. Wosnessenski (specimens in the

Museum) on Unalaska Island. The Ptarmigan of this island Stejneger described under the name *Lagopus rupestris nelsoni* (Auk, vol. 1, p. 226, 1884). The agreement in their bright coloration of the Ptarmigans of the northern Ural with those of the Aleutian Islands and the difference from the paler birds of the more northern countries form a striking confirmation of Seebohm's hypothesis, as put forward in his work on the birds of Japan, that the intensity of coloration in birds of wide range is a result of the temperature to which they are exposed during moult. The northern Ural and the Aleutian Islands are traversed by the same isotherm of + 10° centigrade for the month of July, whereas all the specimens coming from higher latitudes undergo their moult at lower temperatures.

The birds collected by Seebohm at the mouth of the Yenisei were regarded as *Lagopus rupestris* and so should be of a russet tint lacking the grayish color. The two males in autumnal plumage brought back by the Russian Polar Expedition from Western Taimyr (Plate 38) as well as a specimen secured on the Boganida by Middendorff, are characterized by an altogether peculiar coloration. The upper parts are of a pale yellowish gray finely vermiculated with black and quite lack the blackish bases to the feathers. They most resemble the figure of a male *Lagopus rupestris* (Gmelin) in Dresser's work (Birds of Europe, vol. 7, pl. 481, 1874) representing a bird from Iceland. Three specimens, two of which are immature, collected by the Hydrographic Expedition to the Arctic Ocean in the region of Taimyr Strait, have a more brownish coloring but are absolutely similar to specimens in the Museum coming from Iceland. At the same time a considerable series also secured by the latter expedition in the eastern part of Taimyr (as at Hafner Bay and at Nordvik Bay near the mouth of the Chatanga) are of a much darker tint. In a recently published memoir P. Serebrowsky (Journ. f. Ornith., vol. 74, p. 696, 1926) recognized the Ptarmigans of the Siberian tundra from the Taimyr peninsula to the Chuckche peninsula as a distinct subspecies and named it *Lagopus mutus pleskei*. In my opinion it will be more nearly correct to name it *Lagopus rupestris pleskei*.

The Russian Polar Expedition found *Lagopus rupestris* (Gmelin) on 13 and 15 September 1900 at Middendorff Bay, Western Taimyr (Walter, 1901, 1902, *et in litt.*; Birula, 1907). Two males taken on the latter date were in autumnal plumage (Plate 38). Their backs, however, are still entirely dark, of a comparatively pale yellowish brown, the feathers very finely vermiculated with black. They agree perfectly with Dresser's figure of the male *Lagopus rupestris* from Iceland. A similar specimen was killed by Birula (1907) 20 September 1900 at Kolomeitzeff Bay, Western Taimyr. Evidence of *Lagopus* was also found in the region of Bay of Wolves and in the vicinity of the "Sarja's" first winter-quarters, where Baron Toll killed the last specimen 29 October. In the spring of 1901 no fresh tracks of Ptarmigan were seen till 30 April (Walter, 1902). On 7 June was heard for the first time the courtship call of the Rock Ptarmigan, though the

bird still carried its complete white winter plumage, and only the absence of some of the feathers of the neck, evidently lost in some fight, indicated the beginning of the mating period. A male killed 24 June was still entirely white. From 29 October 1900 to 30 April 1901, that is for nearly six months, the Rock Ptarmigan was not to be seen in the vicinity of the "Sarja's" winter-quarters in Taimyr and it is an open question whether it winters there occasionally or whether it deserts these regions altogether during the winter.

In Eastern Taimyr (Sect. XIII), Baron Toll (*l.c.*, p. 276) noted the presence of the Rock Ptarmigan, 1 May 1901, in Hafner Bay; while in the latitudes of the mouth of the Lena (Sect. XIV) Brusneff killed a male in winter plumage 10 June 1902, on the Elijdep promontory. In the New Siberian archipelago (Sect. XVI) neither the Russian Polar Expedition nor Dr. Bunge found this Ptarmigan, but Birula (1907) tells us that according to the natives a limited number inhabit the rocky mountains of Great Ljakoff Island, such as the Chaptagai-tas, the Kovrischka-tas and Emij-tas. The Rock Ptarmigan inhabits also the mountain summits of the Yana delta (Sect. XV), as Muksunovka-taka, Charistan-taka and Yurumchastach-taka, as also according to Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 273, 1887) the latitudes of Cape Swjatoi Noss.

FALCONIFORMES.

Falconidae.

Hierofalco gyrfalco (Linné) (=**Falco rusticolus** Linné).—I should preface my notes on the species of Gerfalcons inhabiting the Eurasian tundra region or that occasionally appear there, by remarking that I find it expedient to consider the data on these birds under two heads: in the first place we have a series of notes, unfortunately rather limited, based on specimens secured by travelers. These should serve first of all as a basis on which to define the geographical distribution of each species. In the second place we have more numerous observations on Gerfalcons which naturalists were unable to secure and whose identification must remain doubtful. Such data are for the most part of very little value since the three forms of Gerfalcon occurring in the Eurasian tundra do not have such well-defined areas of distribution that it would be possible to refer any considerable part of these notes to one or another of the forms.

For Spitzbergen (Sect. I) König (Avif. Spitzb., p. 140, 1911) enumerates a long list of records for Gerfalcons, but in no instance could the precise identity of the form be given. Of two specimens of these birds secured in Spitzbergen, one, as we shall see later, represents unquestionably *Hierofalco islandus* (Brünnich) and the other belongs probably to the same form. The Gerfalcon of the continent of Europe has therefore not been certainly recorded from Spitzbergen. Along the Murman coast (Sect. III) *Hierofalco gyrfalco* (Linné) unquestionably breeds regularly, as well as on those mountain summits (*tunturi*) in Lapland that are high enough to reach the alpine zone. Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 128, 1903) obtained sets of fresh eggs of this species on the Pasvig River 10 May 1899 and in the western part of the Murman coast at Yeretiki 30 May. The Kanin peninsula (Sect. IV) is also undoubtedly inhabited by the continental form of the Gerfalcon, for the collection of Professor M. Menzbier includes three adult males from that region (Fauna of Russia, vol. 6, pt. 1, p. 320, 1916, in Russian) and the eggs obtained by Meves (Oefv. Kongl. Svenska Vet.-Akad. Förh., 1871, no. 6) probably belong to this form. For Kolguev Island (Sect. V) we have no records, but the regions of the mouth of the Pechora are probably inhabited by the Norwegian Gerfalcon for in Professor M. Menzbier's collec-

tion there are two adult males and an adult female coming from the lower course of the Pechora. On Vaigach Island (Sect. VII) Gerfalcons have been observed, but the subspecies has not been exactly determined; while between that island and Nova Zembla at the entrance of Kara Gates, Gillett (Ibis, 1870, p. 304) believes he saw young Gerfalcons. Further, von Heuglin (Reisen im Nordpolarm., vol. 3, p. 83, 1874) at Nova Zembla saw an individual at Matochkin-shar and a second at the mouth of the Nechvatova. This latter bird was white with dark transverse markings. Smirnow states (Nature and Hunting, 1903, no. 8, p. 46–48) that on 8 and 12 August 1879 at Malijy Karmakuly, Goebel saw two Gerfalcons of which the second was almost entirely white [?probably *Hierofalco candicans* (Gmelin)]. Bilkiewicz (App. Mat. Sci. Exped. Univ. Kasan, p. 25, 1904) tells us that Woronin's fishermen in the Kostin-shar killed a pure white Falcon, probably likewise *Hierofalco candicans*. Nossilow (Tour du monde, p. 94, 1894) also lists *Falco gyrfalco* among the birds of Nova Zembla. The identity of the Nova Zembla Gerfalcons remains imperfectly known but we may admit that a proportion of the individuals seen doubtless belong to the Greenland form, *H. candicans* (Gmelin), but at the same time a certain number of the observations refer also to *Hierofalco gyrfalco* (Linné) or to *Hierofalco islandus* (Brünnich). Finally Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 127, 1853) records dark-colored Gerfalcons on 1 July on the Novaja River, again in the month of August in Taimyr Bay and as far as Baer Island in latitude 75° 30′ north (Sect. XII). The identification of all these birds only observed is uncertain. The Russian Polar Expedition nowhere met with representatives of the genus *Hierofalco*.

Hierofalco (=Falco) islandus (Brünnich).—*Local name:* in Yakut; *kŏnt* (Bunge). The Icelandic form of Gerfalcon has been definitely recorded from Spitzbergen (Sect. I) by Münsterhjelm (Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910): on 17 September 1910 a dead and dried specimen was found in Research Bay, that from the photograph published by this author undoubtedly represents the Icelandic race. Professor Mathey-Dupraz (Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 91, 1913) records that during his stay at Greenharbor, Spitzbergen, in February 1912, Engineer Hagerup of Tromsö presented him with a Falcon that he had killed in the summer of 1911 at the whaling station. This specimen, on account of its lack of proper preservation was no longer in condition to be skinned, but according to his statement it was an immature bird of the Icelandic form. Engineer Hagerup's identification of the bird seems to me to require confirmation so that the proper reference of this individual remains uncertain. In the region of the mouth of the Pechora (Sect. VI) the occurrence of the Iceland Gerfalcon may be considered established inasmuch as Professor Menzbier's collection (Fauna of Russia, vol. 6, pt. 1, p. 301, 1916, in Russian) contains four specimens of this bird from the Pechora. Lastly the young female obtained in 1883 by Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 43, 1888) at the mouth of the Lena (Sect. XIV) has been identified by Professor Menzbier (*l.c.*) as the Iceland Gerfalcon. In the same region, Dr. Bunge (*l.c.*, vol. 11, p. 592) observed on 7 November 1882, a second individual very much marked, that he was unable to secure, and which he was also not able to identify positively.

Hierofalco (=Falco) candicans (Gmelin).—The White Gerfalcon has been recorded from the following localities in the Eurasian tundra region: in the northern Ural (Sect. X) according to Backlund (Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 28, no. 1, p. 86, 1911) a White Gerfalcon (probably *Hierofalco candicans* (Gmelin)) nests in the region of the Kara River. Bilkiewicz (App. Mat. Sci. Exped. Univ. Kasan, p. 25, 1904) tells us that the crew of the fishing vessel of Woronin informed him that in the southern part of Nova Zembla (Sect. VIII, a), specifically at Kostin-shar, they had succeeded in killing a perfectly white diurnal bird of prey, which was perhaps a Gerfalcon (see also the observations of Goebel under *Hierofalco gyrfalco* (Linné)). In the Franz Josef archipelago (Sect. IX), specifically at Cape Flora, Dr. Neale (Proc. Zool. Soc. London, 1882, p. 653; Jackson, A Thousand Days in the Arctic, p. 400, 1899) saw a Falcon on 24 April 1882, that seemed to him pure white. An adult female of this race of Gerfalcon was killed 12 May 1893 by Baron Toll on the Chubukulach River, west of the mouth of the Lena (Sect. XIV) and was identified by Professor M. Menzbier (Fauna of Russia, vol. 6, pt. 1, p. 279, 1916, in Russian). Koren on his expedition (see Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 34,

1914) noted the presence of Gerfalcons in various places of the northern coast of the Chukchi peninsula (Sect. XXI), notably on 12 September 1911 at Cape Kibera, 10 September 1912 at Cape Irkaipij and 20 October 1912 at Iksurin. The first of these birds, the one at Cape Kibera, was perfectly white.

49. Falco peregrinus griseiventris Brehm.

Falco peregrinus Linné. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901. Toll, *ibid.*, vol. 20, no. 5, p. 158–160, 1904. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 1, 1907. Toll, Die russ. Polarf. d. "Sarja," p. 591, 1909.
Falcon. Kolomeitzeff, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 5, p. 507, 1902.

List of Specimens from the Russian Polar Expedition.

Skin: adult, 8 August 1902, Lake Sypygyjach, Charaulach Mountains (M. Brusneff).
Egg: one, 14 August 1900, Dickson Bay, mouth of the Yenisei (Dr. Walter).

Local names: in Samoyede, *chapu-ei* (Menzbier); on Kolguev Island, *har-na-wê* (Trevor-Battye); in Yakut, *muksogol* (Bunge); in Ostiak, *chung;* in Tunguse, *teerga* (Menzbier).

There may be a certain difference between the Peregrine Falcons that inhabit the western part of the Eurasian tundra as far as the Lena region, and those of the eastern part (to the east of the Lena). The western form undoubtedly represents the *Falco peregrinus griseiventris* Brehm. The eastern form has been separated by Buturlin (Venery and Hunting, 1907, p. 99, in Russian) under the name of *Falco peregrinus harterti,* characterized by being darker above, with the ashy tint of the head and fore part of the back much less developed, by having the coloration of these parts of a pure dark slate color and the streaks of the under side of a slaty black. Professor Menzbier, in his recent work on the Falcons of Russia (Fauna of Russia, vol. 6, pt. 1, p. 59, 1916, in Russian) has already expunged the supposed race described by Buturlin and made it a synonym of the typical form, *Falco peregrinus peregrinus.* In his list of specimens (*ibid.*, p. 60, *et seq.*) he refers all those from the mouth of the Pechora to the mouth of the Lena, to the form *Falco peregrinus griseiventris* Brehm while identifying specimens from the region of the Kolyma and from the Chukchi peninsula as belonging to the typical form, *Falco peregrinus peregrinus* (Linné). The single specimen brought back by the Russian Polar Expedition, killed by Brusneff, 8 August 1902, near Lake Sypygyjach in the Charaulach Mountains at the mouth of the Lena, represents in my opinion, a perfectly typical *Falco peregrinus griseiventris* Brehm with relatively pale colors and a somewhat extensive ashy wash on the upper parts. This form, in addition to its peculiarities of coloring, should be regarded as a representative of the Peregrine Falcon characteristic of the tundra zone, further distinguished by its habit of nesting exclusively on the ground in moss-covered marshes in the southern parts and in the tundra in the northern parts of its range.

The Peregrine Falcon does not occur in Spitzbergen (Sect. I), on Bear Island (Sect. II) or in the Franz Josef archipelago (Sect. IX). Along the Murman coast (Sect. III)

it has been recorded as breeding in various localities by Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 108–109, 1903, in Russian). For the Kanin peninsula (Sect. IV) reports of it are lacking, by chance as we must suppose, for there is no reason to doubt that it nests there. It is known to occur on Kolguev (Sect. V) and Vaigach (Sect. VII) Islands as well as in the region of the mouth of the Pechora (Sect. VI); it inhabits both islands of Nova Zembla (Sect. VIII) and should not be rare there for it has been recorded by a long list of explorers (Gillett, Nossilow, Pearson, Buturlin, Molchanow, Schaanning and Gorbunow). In the region of the mouth of the Ob, including the Yamal peninsula (Sect. X), and of the Yenisei (Sect. XI), it has likewise been observed but does not seem to extend to the Taimyr (Sects. XII, XIII) for no one has hitherto recorded it from there. Off the mouth of the Lena River (Sect. XIV), it nests everywhere and was found by Quartermaster Tolstow (*in litt.*) 12 June 1903 on Faddejefski Island of the New Siberian archipelago (Sect. XVI), and was likewise observed by the late Baron Toll (1909) on Bennett Island (Sect. XVII). For Wrangel and Herald Islands (Sect. XX) we lack data.

The Russian Polar Expedition met with a pair of Peregrine Falcons 14 August 1900 in Dickson Bay (Sect. XI) (Walter, *l.c. et in litt.*) circling about over their nest on the cornice of a steep cliff. The nest contained a single sterile egg with the following dimensions: 51 mm. x 43 (423 cg.). Again, according to Brusneff (*in litt.*) this species breeds on the mainland, sometimes on the mountains, sometimes on the tundra, placing its nest, as for example in the Bykow peninsula, on the tops of the hillocks. He found on 8 August 1902, near Lake Sypygyjach in the Charaulach Mountains, a nest containing four young (see Pl. 26, fig. 1). Finally S. Tolstow found on 12 June 1903 a pair of these Falcons on Faddejefski Island and Baron Toll (1907) a single individual on Bennett Island.

We have the following notes at hand as to the periodic events in the life of the Peregrine Falcon in the Eurasian tundra region. On Vaigach Island, Pearson (Ibis, 1898, p. 196) found three eggs, 29 June 1897, and on 18 July 1897, three young in down. On the north island of Nova Zembla the same observer (*l.c.*) on 10 August found four young birds, two of which were able to fly, while Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 313, 1908) on 2 August found four young birds at Matochkin-shar, the youngest of which was still in down and the oldest was beginning to acquire its contour feathers. Finally Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 53) found on this island, 28 July 1903, a newly hatched young bird.

Falco peregrinus peregrinus Tunstall.—In the preceding account of *Falco peregrinus griseiventris* Brehm, relying on the opinions of Buturlin and Menzbier, I have admitted the possibility of there being some difference between the Peregrine Falcons of the western and the eastern parts of the Eurasian

tundra. I must add the following note to what I have said in regard to *Falco peregrinus griseiventris* Brehm. I find it very probable that the latter represents the form characteristic of the tundra and should be regarded as an arctic race of the Peregrine Falcon. On the other hand the typical form represents the boreal race of the Falcon and occurs in the neighborhood of the tundra only where the forest zone approaches the shores of the Arctic Ocean as it does particularly along the Siberian coast from the mouth of the Lena to the north coast of the Chukche peninsula. From this point of view, the typical form may be conceded to occur, at times perhaps along with *Falco peregrinus griseiventris* Brehm, in the latitudes of the mouths of the Yana (Sect. XV), the Indigirka (Sect. XVIII), and the Kolyma (Sect. XIX) as well as on the north coast of the Chukche peninsula (Sect. XXI). From the last area, the Peregrine Falcon has not hitherto been reported, but in view of the fact that Baron Maydell found the species in the interior of this peninsula (specimen in our Zoölogical Museum, identified by Professor Menzbier), we may assume that it also occurs along the northern coast.

According to Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 105, 1887), at the mouth of the Yana (Sect. XV), north of 70° north latitude, young Falcons had not yet left the nest on 22 August 1885.

50. Aesalon (=Falco) aesalon (Tunstall).

Falco aesalon (?). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901.

Local names: in Samoyede on Kolguev Island, *irrah* ? (Trevor-Battye); on the north coast of the Chukche peninsula, a bird of prey of the size of a Sparrowhawk was called by the Chukches *jejchiech* (Palmén).

The Merlin is a representative of the fauna of the subalpine zone and the lower parts of the alpine zone, so is to be included as a breeding bird in the regions of the southern limit of the Eurasian tundra. It has not been recorded from Spitzbergen (Sect. I) itself, but it has been observed in the latitudes of this archipelago by Münsterhjelm (Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910), 1 May 1910 at sea in latitude 73° 31′ north and longitude 14° 50′ east, and again in the middle of May in latitude 74° north and longitude 10° east. According to Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 108–109, 1903, in Russian) it is found along the entire Murman coast (Sect. III) and nests in the western parts of that coast (Varanger Fjord, Pasvig River, latitudes of the Rybatschi peninsula). It has likewise been recorded from Kolguev Island (Sect. V) and from Vaigach Island (Sect. VII) as well as the region of the mouth of the Pechora (Sect. VI). On the south island of Nova Zembla a small Falcon was found by Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 312, 1908) and a specimen of *Aesalon aesalon* (Tunstall) was sent thence to our Zoölogical Museum by Professor A. Grigorieff; while at Matochkin-shar according to von Heuglin (Journ. f. Ornith., vol. 20, p. 464, 1872) Captain Melsom several times noted small Falcons, and Nossilow (Tour du monde, p. 94, 1894) likewise lists the Merlin among the birds of this double isle. Finally, Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 52) states that it is common in the region of Matochkin-shar, and arrived there 8 June 1903. Heuglin (*l.c.*) tells us also that a specimen of this species was captured in the Kara Sea (Sect. X) and sent to Professor Collett. In the same section, specifically in the eastern part of

Jugor Strait, Nansen (Collett and Nansen, Norw. North Polar Exp., p. 6, 1899) observed a pair that evidently had young. More recently a young bird was killed between the rivers Talata and Nunderma (Sect. X), 24 August 1909, by J. Wardropper, naturalist of the Expedition to the Northern Ural under H. Backlund. At the mouth of the Yenisei (Sect. XI) Popham (Ibis, 1898, p. 508) found the Merlin on one of the Brekhoffski Islands and probably birds of this species were seen by Nansen (Collett and Nansen, *l.c.*) on Renö Island of the Kjellman group (in latitude 74° 46′ north and longitude 85° 42′ east) and by Dr. Walter (1907) were several times noted in the autumn of 1900 in Middendorff Bay, Western Taimyr (Sect. XII). At the mouth of the Lena (Sect. XIV) Dr. Bunge saw what he believed to be this species up to 73° 25′ north latitude (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 593, 1883) and in the regions of the Yana (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 105, 1887) up to 70° 30′ north latitude. Finally on the north coast of the Chuckche peninsula (Sect. XXI) members of the "Vega" Expedition saw some small birds of prey, probably Merlins, 18 September 1878 at Irkajpij and 27 May 1879 at Jinretlen.

51. Haliaëtus (=Haliæëtus) albicilla (Linné).

Haliaëtus leucocephalus. Toll, Die russ. Polarf. der "Sarja," p. 591, 1909.

Local name: in Samoyede, *limbe* (Zitkow).

The Sea Eagle inhabits the coasts of the Eurasian Arctic Ocean and must breed there, though in comparatively limited numbers. Along the Murman coast (Sect. III) Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 108–109, 1903) observed it from Varanger Fjord to the mouth of the White Sea, but was nowhere able to determine that it nested. It is possible that it breeds chiefly in the neighborhood of the great lakes in the interior of Lapland and frequents the shores of the Arctic Ocean mostly in autumn, winter and spring, but the Sea Eagles seen in 1880 by Nikolski (Mém. Soc. Nat. St. Pétersbourg, vol. 16, pt. 1, p. 345, 1885, in Russian) on Goussinetz Island near Gawrilowo and near Teriberka may have nested there. Under similar circumstances this species has been reported in the Kanin peninsula (Sect. IV), the region of the mouth of the Pechora (Sect. VI), Vaigach Island (Sect. VII), breeding according to the Samoyedes in the south island of Nova Zembla (Sect. VIII, a) (Molchanow, Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 314, 1908), from the Yamal peninsula (Sect. X), from Taimyr (Sect. XII) and the mouth of the Yana (Sect. XV) while the data relating to the mouth of the Lena (Sect. XIV) and the Indigirka (Sect. XVIII) are given with a question-mark, probably because the identification of the species was uncertain. On Bennett Island (Sect. XVII) Baron Toll (*l.c.*) noted a Sea Eagle on passage going in a south-to-north direction, but he called it *Haliaëtus leucocephalus* (Linné). Finally Buturlin (Ibis, 1906, p. 132) tells us

that this species appeared in 1905 before the last of May at the mouth of the Kolyma (Sect. XIX).

Haliaëtus (= **Haliæëtus**) **leucocephalus alascanus** Townsend.—This subspecies has been reported by Thayer and Bangs (Proc. New England Zoöl. Club, vol. 5, p. 33, 1914) from the extreme northeast of Siberia, on the north coast of the Chuckche peninsula (Sect. XXI).

Archibuteo (= **Buteo**) **lagopus lagopus** (Brünnich).—The western form of Rough-legged Buzzard inhabits the rocky parts of the zones of shrub growth (*Regio subalpina*) and of the tundra (*Regio alpina*). It is therefore abundantly distributed in these zones along the Murman coast (Sect. III) and is everywhere found in the interior of Lapland where the mountain-tops rise above the limit of the forest region. It is likewise reported from the Kanin peninsula (Sect. IV), from Vaigach Island and from Jugor Strait (Sect. VII). In the regions of the mouth of the Ob, especially in the Yamal peninsula (Sect. X) and at the mouth of the Yenisei (Sect. XI), it is replaced by the pale form characteristic of eastern Siberia.

52. **Archibuteo** (= **Buteo**) **lagopus pallidus** Menzbier.

List of Specimens from the Russian Polar Expedition.

Skin: (adult male), 1 August 1902, Choptolach River, mouth of the Lena (M. Brusneff).

Eggs: one, 31 July 1902, same place and collector; four, 17 June 1903, Tiksi Bay, Bykow peninsula, mouth of the Lena (Th. Matiessen).

Local names: in Samoyede on the Yamal peninsula, *nyera* (Zitkow); in Yakut, *borular* (Bunge).

The single specimen of this *Archibuteo* brought back by the Russian Polar Expedition from the mouth of the Lena seems to me referable to the pale eastern form described by Professor Menzbier under the name of *Archibuteo lagopus pallidus*. Most of the specimens, including the one figured by Menzbier (Birds of Russia, vol. 2, p. 180, 1895, in Russian), that on account of their pale tints belong unquestionably to this form, are immature birds. Among the considerable series in our Zoölogical Museum, I have been unable to find adult birds in a wholly pale plumage. On the other hand I have found a rather large number of quite adult *Archibuteo* coming either from the northeastern part of Siberia (their breeding ground) or from Ussuri Land and Turkestan (their area of passage or perhaps to some extent of wintering), that were quite as widely distinct from the typical form as the specimens in the collection of Professor Menzbier, who has made the birds of prey the object of his special study and has labeled these specimens *Archibuteo lagopus*, var. The dark parts of their plumage, especially the back and scapulars, the dark markings below and the very striking transverse bars of the tail, are of a much darker brown than in the typical form, of a blackish tint. But on the other hand the pale portions are more extensive and of a purer white so that the contrast between the pale and the dark areas becomes much more obvious. The specimen brought back by the Russian Polar Expedition agrees completely with those coming from the countries mentioned but is in turn hardly distinguishable from an American *Archibuteo lagopus sanctijohannis* (Gmelin) taken in Labrador. If the latter race did not occur in two very different plumages (a pale form and one almost altogether brown)

I should not hesitate to regard the form of eastern Siberia identical with the American form. But the entire absence of brown individuals in Siberia prevents me from accepting the alternative but inclines me to believe instead that in common with a good number of other species of animals, the *Archibuteo* that breed in eastern Siberia and to which the name *Archibuteo lagopus pallidus* Menzbier is applied, represents a form intermediate between the typical and the American subspecies. During the breeding season this race inhabits the regions of the Ob river-system (Sect. X), of the Yenisei (Sect. XI), probably the interior of Taimyr peninsula (Sects. XII, XIII), the river-systems of the Lena (Sect. XIV), the Yana (Sect. XV), the Indigirka (Sect. XVIII), the Kolyma (Sect. XIX), and has been recorded with reservation from Great Ljakoff Island (Sect. XVI) by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 383, 1887). The Russian Polar Expedition found the Rough-legged Buzzard only in the regions of the mouth of the Lena (Sect. XIV) whence Brusneff secured for us the adult male and the egg above mentioned and Th. Matiessen, in Tiksi Bay, the set of four eggs. According to Brusneff's notes (*in litt.*) the Rough-legged Buzzard nests throughout the rocky parts of the tundra in these countries and on the summits of the hills. The nests are constructed of twigs.

1. Four eggs, 17 June 1902, Tiksi Bay, Bykow peninsula, mouth of the Lena (*Th. Matiessen*).—These eggs were heavily incubated. Two of them have an abundance of russet-brown markings, while the third is covered with a good number of small russet-brown spots. The fourth egg is covered with pale spots of a yellowish brown. Dimensions and weights: 54.6 mm. x 43 (521 cg.); 55 x 41 (468 cg.); 55 x 43 (–); 55.8 x 42.6 (–).

2. Three young and two eggs, 31 July 1902, Choptolach River, mouth of the Lena (*M. Brusneff*) (*Pl. 26, fig. 2*).—One of these eggs, to judge from the size of the opening through which it was emptied, was unincubated and evidently sterile. It is covered with pale dull spots, some of a clear gray, some yellowish. It measures: 56.5 mm. x 45 (511 cg.).

The eggs found by Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 317, 1912) at the mouth of the Morda River on the Yamal peninsula (Sect. X) were slightly incubated and on 3 July a nest was found in the valley of the same river that contained young in down. On 13 July 1912, Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 33, 1914, under *Archibuteo lagopus lagopus* Brünnich) found a nest at Cape Bolschoi Baranovski, containing four young birds five or ten days old.

Astur palumbarius (=**Accipiter gentilis**) (Linné) subsp.?—The Goshawk nests according to Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 108–109, 1903, in Russian) in the western parts of the Murman coast (Sect. III) but appears only casually in the eastern. It has been reported by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 104, 1887) from the mouth of the Yana (Sect. XV) and the Hydrographic Expedition to the Arctic Ocean secured a specimen at the mouth of the

Kolyma (Sect. XIX). The latter is an immature bird so that it is impossible to tell whether it belongs to the typical form or to the Siberian race, *Astur palumbarius schredowi* Menzbier. It is of a rather dark russet color and I presume it must represent the Siberian form.

ANSERIFORMES.

Anatidae.

Before enumerating the representatives of the subfamily Cygninae that regularly inhabit some parts of the Eurasian tundra, or else are of casual occurrence there, I must call the reader's attention to the fact that in various parts of the region under discussion Swans have occasionally been seen but the exact identification of the species has been possible in only a few cases. This is especially true of Spitzbergen (Sect. I) where Swans have many times been observed but only two specimens have been taken. The possibility that the observed but not secured birds were Wild Swan (*Cygnus cygnus* Linné) that had wandered here, cannot be denied, but on the other hand they may have been Bewick's Swan (*Cygnus bewickii bewickii* Yarrell). Further, in Buturlin's opinion as previously published (see Dresser, Eggs Birds Europe, p. 545, 1910), the record of *Cygnus olor* (Gmelin) for the mouth of the Lena by Palmén (Sibir. Ishk. Fogelf., tab. 7, 1887) evidently inserted on the authority of Bunge's statement (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 47, 1888), is unquestionably founded on an error.

Cygnus cygnus cygnus (Linné).—The Wild Swan cannot strictly be included as a member of the fauna of the Eurasian tundra but is an occasional visitor there, and even nests in places on the southern border of this region. A species of Swan (*Cygnus* sp.?) was taken about 1861 at Stor Fjord in Spitzbergen (Sect. I) and others were seen at Ice Fjord as well as by Captain Kuylensterna in August 1861 in Advent Bay (Jourdain, Ibis, 1922, p. 163). According to Langstaff (Ibis, 1924, p. 483) M. P. Brandal in the month of August, about 1900, killed a pair out of a flock of Swans that frequented Red Bay. Finally, A. Lewin's party saw a flock of Swans in Dickson Bay in August 1922. It has been recorded by Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 120–121, 1903, in Russian) in the western parts of the Murman coast (Sect. III) and was likewise observed by Seebohm (Ibis, 1876, p. 437) at the mouth of the Pechora (Sect. VI). As to Nova Zembla (Sect. VIII, a), Bewick's Swan regularly breeds there, but we have at hand a series of records which force us to conclude that the Wild Swan is an accidental visitor to the southern island: (1) Von Baer (Bull. Acad. Sci. St. Pétersbourg, vol. 3, p. 351, 1838) mentions the Wild Swan from Nova Zembla, but since he omits Bewick's Swan, he may have confounded it with the latter species; (2) Prince Uchtomski (Nova Zembla, p. 32, 1883, in Russian) lists both species; (3) Goebel (in Smirnow, Nature and Hunting, 1903, no. 6, p. 15) saw some large Swans, 12 August 1879, near Malijy Karmakuly and killed one of them, while late in June eggs of this species were brought to Tjagin who had wintered there; (4) Smirnow (Nature and Hunting, 1902, no. 1, p. 14, in Russian) tells us further that the sailor Dikin saw two or three individuals that were larger than one just killed at the time mentioned; (5) Smirnow (Ornith. Jahrb., vol. 12, p. 210, 1901) also noted large Swans in Kussow Land; (6) Gorbunow tells me (*in litt.*) that a Wild Swan was killed in 1925 by P. Ushakow in Chernaja Bay. According to Jordans (Journ. f. Ornith., vol. 73, p. 449, 1925), two pairs of Wild Swans were seen at Nova Zembla. The Wild Swan likewise breeds in the forested region of eastern Siberia whence it may occasionally wander to the coasts of the Arctic Ocean. It is therefore possible that Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 134 (Lena) and p. 115 (Yana), 1887) was correct in identifying the Swans he saw at the mouths of the Lena and the Yana as Wild

Swans, yet the possibility is not eliminated that he confounded them with the eastern form of Bewick's Swan, which reaches a larger size than the western race.

53. Cygnus bewickii bewickii Yarrell.

Cygnus sp.? Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 386, 1901.

Local name: in Samoyede, *horch* (Trevor-Battye).

Bewick's Swan, ranging along the entire seaboard of the Eurasian Arctic Ocean from the Murman coast (Sect. III) to the regions of the mouth of the Kolyma (Sect. XIX), attains a larger size in the eastern parts of this area, and differs further in the width of the bill (28–31 mm. in *C. bewickii bewickii* against 31.5–36 mm. for *C. bewickii jankowskii*) from specimens coming from the western part of the species' range. The eastern form was described by Alphéraki as *Cygnus bewickii jankowskii*. I prefer to regard the two extreme forms as constituting a single species having smaller dimensions in the west and larger measurements in the east, as we see in a whole series of species whose ranges extend across the northern part of the Eurasian region. This point of view would find confirmation further in the fact that the two forms do not have separate areas of distribution but occur for example at the mouth of the Lena in almost equal numbers. Thus of nine specimens coming from this region, four according to Buturlin (Ibis, 1907, p. 650–652) belong to the typical form while five represent *Cygnus bewickii jankowskii* Alphéraki. Farther to the eastward the latter form completely replaces the typical race, so that at a certain point it may be regarded as a distinct subspecies and separately treated.

According to Montague (Ibis, 1926, p. 138) a Bewick's Swan was killed in Spitzbergen (Sect. I) at Whalenburg Bay, Northeast Land, and determined at the British Museum; in April 1924, a flock of these Swans was observed in Ice Fjord.

The typical form of Bewick's Swan frequents the littoral of the Murman coast (Sect. III) on migration only and does not breed there. Its nesting grounds begin at Kolguev Island (Sect. V) and extend as far as the mouth of the Pechora (Sect. VI), Vaigach Island (Sect. VII), the south island of Nova Zembla (Sect. VIII, a), the mouths of the Ob (Sect. X), and of the Yenisei (Sect. XI), the Taimyr peninsula as far north as latitude 74° to 74° 30′ (Sects. XII and XIII), and reach the mouth of the Lena (Sect. XIV) where they meet those of the eastern form. Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 78) found the Swan breeding in considerable numbers in the vicinity of Pankova and Matochkin-shar, Nova Zembla. The first ones appeared there 28 May; egg-laying commenced 5 June and hatching of the young 16 July 1903. On 23 and 27 August and on 1 September birds were seen that on account of being in moult, were unable to fly.

On 15 September 1900, the Russian Polar Expedition saw four Swans in Middendorff

Bay, Western Taimyr (Sect. XII), that undoubtedly were of this form. They were going southward.

54. **Cygnus bewickii jankowskii** Alphéraki.

List of Specimens from the Russian Polar Expedition.

Skins: adult, 12 June 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff).

Eggs: five (of six), 25 June 1903, Bykow peninsula, mouth of the Lena (Th. Matiessen).

Local name: in Chukche, *nerku* (Palmén).

The single specimen of Swan brought back by the Russian Polar Expedition was killed 12 June 1902 by Brusneff, near the Elijdep promontory in the region of the mouth of the Lena (Sect. XIV). It undoubtedly belongs to the eastern form of Bewick's Swan and has the following dimensions: wing, 510 mm.; bare portion of culmen, 101 mm.; from eye to tip of bill, 117 mm.; from nostrils to tip of beak, 42.5 mm.; width of bill, 32.5 mm.

This form, as I have already mentioned above, occurs in the latitudes of the Lena along with the western race and during the breeding season inhabits the eastern coasts of the Siberian Arctic Ocean from the Lena (Sect. XIV) probably to Bering Strait (Sect. XXI) though with regard to the eastern part of the breeding range I must speak with some reservation since the evidence of its presence on the north coast of the Chukche peninsula is not perfectly certain. The "Vega" Expedition (Palmén, Sibir. Ishk. Fogelf., p. 429, 1887) several times noted Swans in the vicinity of the ship's winter-quarters but no specimens were secured and it remains unsettled whether or not this expedition found two species of Swans—*Cygnus bewickii jankowskii* Alphéraki and *Cygnus columbianus* (Ord)—or only one of these.

Buturlin (Ibis, 1906, p. 132) tells us that the first Bewick's Swans appeared at the mouth of the Kolyma in the middle of May 1905, and that small flocks were noted there about 2 June. In the region of the mouth of the Lena, Naval Lieutenant Th. Matiessen succeeded in procuring a set of six eggs of this Swan, of which one was broken. These eggs exceed in size the measurements of eggs of the western bird, a fact which proves that they belong to the eastern race. They are further distinguished by a deeper yellow tint.

1. Five eggs, 25 June 1903, Bykow peninsula (Th. Matiessen).—Dimensions and weights: 106 mm. x 69.5 (3120 cg.); 102.3 x 69.4 (2895 cg.); 106.1 x 68.2 (3152 cg.); 101 x 68.5 (2970 cg.); 106 x 68.5 (3045 cg.).

Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 31, 1914) found on 26 June 1912 at the mouth of the Kolyma River, the nest of a small Swan, but as he was unable to secure the parent birds the form to which they belonged remains uncertain.

?Cygnus (=Olor) columbianus (Ord).—We may admit the possible occurrence of this American species in the regions of the north coast of the Chukche peninsula (Sect. XXI) since this form has been

several times taken in the eastern portions of that peninsula. It is therefore very likely that the observations on Swans made by members of the "Vega" Expedition (Palmén, Sibir. Ishk. Fogelf., p. 429, 1887) in the vicinity of the vessel's winter-quarters, relate wholly or in part to this species. On 20 May 1915, Dr. Savich observed a pair of Swans at Cape Severny, Chuckche peninsula (Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 26, 1927).

55. **Chen hyperboreus hyperboreus** (Pallas).

Chen hyperboreus (Pallas). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, pt. 2, p. 132, 1907.

Local names: in Russian (mouth of the Yana), *bjelij gus* (=white goose); in Yakut, *jurun-kas;* in Tunguse, *geltanjá-eerbéch* (both these names likewise mean white goose) (Birula); in Chuckche, *l'ippa* (Palmén).

Langstaff (Ibis, 1924, p. 483) states that General H. Chermside in 1873 saw white Geese (species undetermined) in Wijde Bay, Spitzbergen (Sect. I). In his memoir cited above, Birula (1907) has shown that even if the older authors, Pallas and Argentoff, were right in stating that Snow Geese formerly inhabited in large numbers the shores of the Arctic Ocean from the mouth of the Lena (Sect. XIV) to Bering Strait (Sect. XXI), they have changed their habits and now no longer do so. He also quite disproves the theory that the Snow Geese nest on the northern islands of the East Siberian Arctic Ocean. The Russian Polar Expedition did not succeed in finding this species anywhere and Birula is the only one who has secured any information about this Goose from the natives. According to their testimony the Snow Goose occurs in limited numbers east of the mouth of the Lena (Sect. XIV), most commonly in the latitudes of the mouth of the Yana and toward the Swjatoi Noss promontory (Sect. XV). Again, one of the natives, Wassily Dzergeli, told him that he had once succeeded (thirty years before) in finding on Great Ljakoff Island (Sect. XVI), a nest of this Goose that contained late in June three heavily incubated eggs, and that he killed the female. In the region of the Indigirka (Sect. XVIII) this Goose has been recorded as a very rare species by Sensinow (Zitkow and Sensinow, Journ. Zoöl. Sec. Soc. Friends of Nat. Sci., Anthrop. and Ethnogr., Moscow, new ser., vol. 3, p. 16, 1915, in Russian): a male was killed near the Russian town of Russkoje Ustje. According to Buturlin (Venery and Hunting, 1906, p. 29, in Russian) the Snow Goose is also very rare at the mouth of the Kolyma (Sect. XIX) and only breeds in any numbers on the north coast of the Chuckche peninsula (Sect. XXI) east of Chaun Bay. The "Vega" Expedition did not succeed in finding the nest of this Goose in the neighborhood of the ship's winter-quarters but brought back a specimen killed 10 June 1879 near Pitlekaj; furthermore, the members of the Expedition saw six birds 14 June and two more on the following day (Palmén, Sibir. Ishk. Fogelf., p. 417, 1887). According to Professor W. Artobolewski (Mem. Kiev Soc. Nat., vol. 27, p. 34, 1927) Dr. Savich, surgeon of the steamer "Kolyma," noted in spring 1915 the arrival of great and numerous flocks of Snow Geese at Cape Severny (Irkaipij), on the north coast of

Chukchi Land (Sect. XXI) between Chaun and Koljuchin Bays. From 26 May to 11 June an intensive migration took place (on 27 May no less than 500 birds were observed); for nesting only a very few remained. No less than nine specimens were killed, two of which have been kindly presented to our Museum by Professor Artobolewski. In 1925, S. Buturlin (Ornith. Monatsber., vol. 34, p. 34, 1926, and W. Ushakow, The Ukraina Hunter and Fisherman, 1925, no. 12, p. 18) visited the Chukchi peninsula and obtained there two specimens of the Snow Goose.

The Russian Polar Expedition did not succeed in bringing back any material on Geese belonging to the genus *Melanonyx*, with the exception of a set of eggs found by Matiessen, 25 June 1903, on Brusneff Island at the mouth of the Lena and sundry notes of Gray Geese obtained by Birula from the natives of the Yana region. The eggs, I believe, should be regarded as belonging to *Melanonyx arvensis sibiricus* Alphéraki but they may quite as well be eggs of *Melanonyx segetum serrirostris* (Swinhoe). I do not feel justified in treating this group of Geese on the basis of the recorded literature on account of the indefiniteness of most of the identifications. Data as to the periodic phenomena relate also for the most part to Geese in general without reference to the particular species observed. I can therefore only list the species and races of Geese of the genus *Melanonyx* that breed either in the Eurasian tundra region itself or in its neighborhood, basing my account chiefly on Alphéraki's monograph (The Geese of Russia, 4to, 1904, in Russian) and on the papers of Buturlin (Journ. Bombay Nat. Hist. Soc., vol. 17, p. 603–607, 1907; vol. 18, p. 555–561, 1908; Our Hunting, 1908, no. 11, p. 21–28), with the addition of more recent records and critical comment.

Melanonyx (=Anser) brachyrhynchus (Baillon).—The Short-billed Goose breeds abundantly in the Spitzbergen archipelago (Sect. I) and is of casual occurrence chiefly in migration time on Bear Island (Sect. II). The expedition of the late Lieutenant Sedow secured a specimen of the Short-billed Goose on the Franz Josef archipelago (Sect. IX). The specimen, forwarded to our Museum, was kindly identified by Professor P. Sushkin. It is the same specimen identified by the late Bianchi (Annuaire Mus. Zool. St. Pétersbourg, vol. 14, p. 14, 1917) as *Melanonyx segetum* (Gmelin). In the Kola peninsula (Sect. III) this species appeared in 1867 at various localities in East Finmarken and probably bred there; one specimen was secured by Nordvi according to Collett (Forh. Vid. Selsk. Christiania, 1868, p. 175, no. 186) while Mela (Vert. Fenn., ed. 1, p. 204, no. 206 B, tab. (266)*, 1882) states that a specimen of this Goose was killed early in the spring in the vicinity of Kola. During my stay at Kola in August 1880, I saw at the house of a functionary of the government four full-grown Geese that had been captured in down plumage near Kola. I wrote down a description of these on the spot from which upon my return I was able to identify them as *Anser brachyrhynchus* Baillon (Pleske, Crit. Rev. of Mamm. and Birds of the Kola peninsula, Russian ed., p. 341, 1887). However, such competent authorities on our Geese as Alphéraki and Buturlin have doubted the correctness of my identification of the species in question and have been unwilling to admit the possibility of the breeding of this Spitzbergen Goose in the Kola peninsula. But in spite of the fact that I no longer have my original notes at hand and that a space of more than forty years has elapsed since my journey to Lapland, I believe, nevertheless, that I must insist even now on the correctness of my original identification, for I am unable to suggest any other species of Goose whatsoever with which I could have confounded the Geese studied twice in Kola.

I recall very clearly that these Geese (1) were a trifle larger than or perhaps equalled in size *Anser albifrons* (Gmelin), that they exceeded *Anser erythropus* (Linné) in size and were certainly smaller than *Melanonyx arvensis* (Naumann) or *Melanonyx segetum* (Gmelin); (2) that they had flesh-colored feet and flesh-colored upper mandibles with brownish-black bases; (3) that the lesser wing-coverts were ashy gray, while the greater coverts were of a dark brown with narrow grayish margins; (4) that their bellies were of a uniform tint without blackish spots. In the course of preparing my memoir on the fauna of the Kola peninsula I secured an authentic specimen of the Short-billed Goose and from a comparison of my notes with this specimen I concluded to identify the Geese seen at Kola as *Melanonyx brachyrhynchus* (Baillon). As I never have made a special study of the Geese I readily admit the possibility of an error on my part; yet I think I could only have confused the birds in question with *Melanonyx neglectus* (Sushkin), at that time unknown. But the latter is of a decidedly greater size and its lesser wing-coverts are not of an ashy tint. In view of all these points I believe that I must maintain my original opinion in the matter and retain this species, with some reservation, in the list of birds of Russian Lapland.

Melanonyx (=Anser) neglectus (Sushkin).—Buturlin (Our Hunting, 1908, no. 11, p. 27) states that this Goose breeds in Nova Zembla (Sect. VIII), particularly on the northern island (Buturlin, in Dresser, Eggs Birds Europe, p. 536, 1910), and probably on Kolguev (Sect. V). No doubt these statements are correct but it seems to me that there is very little actual proof in view of the fact that the only one to bring back a specimen of this Goose from Nova Zembla is Nossilow (Buturlin, Our Hunting, 1908, no. 8, p. 49–64; probably also Nossilow, Tour du Monde, 1894, p. 94, under *Anser brachyrhynchus*?) while Buturlin (Alphéraki, The Geese of Russia, p. 76, 1904, in Russian) saw several heads of these Geese from Matochkin-shar, collected by Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 75), and lastly Goebel presented to the Zoölogical Museum at Petrograd a Goose's egg from Nova Zembla that he referred to *Melanonyx neglectus* (Sushkin) without proof of the identity through a specimen of the bird.

Melanonyx arvensis arvensis (Brehm) (=**Anser fabalis** Latham).—The western form of the Wild Goose nests according to Buturlin (*l.c.*) in Lapland (Sect. III), on Kolguev Island (Sect. V) and in Nova Zembla (Sect. VIII), as well as in the region of the mouth of the Ob (Sect. X) and of the Yenisei (Sect. XI), where according to the observations of Tugarinow (Mess. Ornith., 1910, p. 44) it breeds as far as latitude 71° north.

56. **Melanonyx arvensis sibiricus** Alphéraki.

? *Melanonyx segetum* (Gmelin) *apud* Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 101, 130, 1907.

List of Specimens from the Russian Polar Expedition.

Eggs: six, 25 June 1903, Brusneff Island, mouth of the Lena (Th. Matiessen).

Local names: in Russian in the Yana region, *guménnik* (Harvest Goose); in Yakut, *kongór;* in Tunguse, *njéngan* (Birula).

The eastern form of the Wild Goose nests according to Buturlin (*l.c.*) along the Siberian coast of the Arctic Ocean from Taimyr (Sect. XII) to the north coast of the Chuckche peninsula (Sect. XXI). By analogy with the western race, I presume that this Goose nests in more northern latitudes than *Melanonyx segetum serrirostris* (Swinhoe) and for this reason I deem it best to refer to this species the set of eggs taken by Matiessen 25 June 1903 on Brusneff Island at the mouth of the Lena. From the size of the eggs this set can belong to only one of the species of *Melanonyx* since according to Dresser (Eggs Birds Europe, p. 537, 1910) the eggs of *Anser albifrons* (Scopoli) measure only 79.8–81.2 by 52–54, while those of the set in question measure 81.6–84.5 mm. by

54.8–55.5. A comparison of these eggs with undoubted eggs of *Anser albifrons* (Scopoli) has convinced me that those of the latter species are always smaller. The dimensions and weights of the eggs taken by Matiessen are: 81.6 mm. x 55 (1327 eg.); 82.5 x 54.8 (1335 eg.); 83.1 x 55 (1360 eg.); 81.6 x 55 (1195 eg.); 84.5 x 55.3 (1270 eg.); 82 x 55.5 (1316 eg.).

For the reasons already given, I presume that the notes gathered by Birula (1907) from the natives of the Yana region and cited under (?) *Melanonyx segetum* (Gmelin) probably also refer to *Melanonyx arvensis sibiricus* Alphéraki. According to these statements the Wild Goose (called by the natives *kongór*) is not rare in the tundra from the lower Yana to the Swjatoi Noss promontory. Here it nests and undergoes its moult but occurs in more limited numbers than *Anser albifrons* or *Branta bernicla nigricans*. It is found also at the mouth of the Yana but does not frequent the two neighboring islands, Maequar and Scheloniki. At times in seeking quiet places in which to undergo the moult, these Geese reach not only Great Ljakoff Island but even Kotelny Island. Yegor Chihacheff, one of Birula's companions during his stay on the Island of New Siberia, told him that in 1895 he found a flock of some twenty of these Geese on the Balyktach River, Kotelny Island, and killed some of them. During Birula's passage in 1903 by the mouth of the Yana an old *jukagire* Yegor told him that he had once come upon a Goose of this species (which they called *kongór*) at Solyrdjaeh-ary, on Kotelny Island.

Melanonyx segetum segetum (Gmelin) (=**Anser fabalis** Latham).—The western form of the Bean Goose is listed doubtfully for the Kanin peninsula (Sect. IV) by Pearson (Three Summers among Birds Russ. Lapland, app. 1, 1904). Buturlin (*l.c.*) states that it nests in considerable numbers on Kolguev (Sect. V), but Tolmasheff (*in litt.*) who visited that island in 1925, kindly informs me that the Bean Goose has become very scarce there, due to the persecutions of the natives. It nests, according to Buturlin, at the mouth of the Pechora (Sect. VI) and in smaller numbers in Nova Zembla (Sect. VIII, a). Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 75) states that this Goose was very common in the neighborhood of Matochkin-shar in 1902 and 1903. However, this refers in part to *Melanonyx neglectus* (Sushkin) found by Buturlin among the specimens brought back by Schaanning. It has also been reported from Vaigach Island (Sect. VII). Finally this species has been noted from the Yamal peninsula in latitude 70° north by Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 320–322, 1912) and is found in abundance in the lower Yenisei (Sect. XI) according to the researches of Tugarinow (Mess. Ornith., 1910, p. 45) between latitude 69° and 71° north, that is, in the subalpine zone and at the edge of the forest zone.

Note.—*Melanonyx* (=*Anser*) *segetum carneirostris* Buturlin of Nova Zembla, which differs from the typical form only in the vermilion or flesh-color of the light band on the beak, seems to me to represent only an individual variation or perhaps a peculiarity of age. Hitherto only a few single individuals have been found in Nova Zembla (von Heuglin, Journ. f. Ornith., vol. 2, p. 121–122, 1872; Bilkiewicz, App. Mem. Sci. Exped. Univ. Kasan, p. 27, 1904, in Russian; noted by Smirnow, Ornith. Jahrb., vol. 12, p. 210, 1901, under *Anser rufescens;* on Kussow Land, Nova Zembla by Alphéraki, The Geese of Russia, p. 113, 1904) and in the Yamal peninsula (Zitkow, *l.c.*).

Melanonyx (=**Anser**) **segetum serrirostris** (Swinhoe).—The eastern form of *Melanonyx segetum* nests in small numbers, according to Tugarinow (Mess. Ornith., 1910, p. 46) at the mouth of the Yenisei

(Sect. XI) and thence (according to Buturlin, *l.c.*, p. 27) along the northern part of the Yakutsk government (lower courses of the rivers Lena, Yana, Indigirka and Kolyma) to the latitudes of the Chuckche peninsula (Sect. XXI). Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 29, 1914) observed this Goose in considerable numbers from the mouth of the Kolyma (Sect. XIX) as far as, but not beyond, Cape Schelagskoi. In a set of two eggs found at Cape Bolschoi Baranovski the young hatched 6 July. Copley Amory (Riley, Proc. U. S. Nat. Mus., vol. 54, p. 617, 1918) secured, 18 July 1915, a male of this species in the delta of the Kolyma (Sect. XIX). In the Eurasian tundra zone, this Goose is probably only a casual visitor in those places where the edge of the forest zone approaches the Arctic Ocean.

Note.—? *Melanonyx* (= *Anser*) *segetum mentalis* (Oates).—Buturlin (*l.c.*, p. 28) states that of this form of Goose there is but a single record for the region here treated, namely a specimen that had wandered to the mouth of the Kolyma (Sect. XIX). I quite agree with Alphéraki's view (The Geese of Russia, p. 124, 1904) that this bird without a specific geographic range or breeding ground represents only the old males of *Melanonyx segetum serrirostris* (Swinhoe) with unusually large bill.

57. Anser albifrons (Scopoli).

Anser albifrons (Scopoli). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 386, 1901. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 101, 128, 1907. Toll, Die russ. Polarf. d. "Sarja," pp. 56, 523, 1909.

Anser sp. ? Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902.

List of Specimens from the Russian Polar Expedition.

Skin: adult, 17 June 1902, Elijdep promontory, Charaulach Mountains (M. Brusneff).

Local names: in Russian, latitudes of the Yana, *kasarka* (Birula); in Samoyede, Kolguev Island, *seer-grun* (Trevor-Battye); in Yakut, *lygly;* in Tunguse, *ecrbech,* meaning Goose in general (Birula); in Chuckche, *jajeng* (Palmén).

The White-fronted Goose represents a circumpolar species that inhabits the tundra along the coast of the Polar Sea of the holarctic region. The dimensions of specimens coming from the western parts of its geographic range are smaller and their beaks particularly are shorter, while those to the eastward, especially those from America, are more robust and with longer bills. The latter form was distinguished as a separate species by Hartlaub (Rev. et Mag. de Zool., 1852, p. 7) and described under the name *Anser gambeli,* but later investigations by a number of naturalists (Palmén, Salvadori, Alphéraki, Buturlin) have shown that the size of the bills in White-fronted Geese increases gradually as one goes eastward and that there is a complete intergradation between the extremes. For these reasons the White-fronted Geese can only be regarded as belonging to a single species.

The single specimen of White-fronted Goose brought back by the Russian Polar Expedition is probably a female and measures from the forehead to the tip of the bill 48 mm., which is about an average measurement for the bill of this Goose (42 to 60 mm.).

Anser albifrons (Scopoli) is completely absent from Spitzbergen and Bear Island. As to the Kola peninsula (Sect. III) I maintain the opinion I previously expressed in my

work on the avifauna of this country (Crit. Rev. of the Mamm. and Birds of the Kola peninsula, Russian ed., p. 346, 1887) that the White-fronted Goose appears there on passage only (evidently in limited numbers) and that it does not breed there. I insist on the correctness of this view in spite of Goebel's statement which Alphéraki (The Geese of Russia, p. 47, 1904, in Russian) believed he should have included in his monograph on the Geese of Russia, to the effect that two Geese which Goebel took for White-fronted Geese had been brought by the Lapps in 1897 from Lake Noto to Mr. Auvikaine, the forester of Kola. Goebel's account of these birds contains so little that is diagnostic that I even hesitate to decide whether the birds concerned were representatives of the subgenus *Melanonyx* Buturlin or if they were White-fronted Geese.

The regular breeding ground of this species begins therefore at the Kanin peninsula (Sect. IV) and extends to Kolguev Island (Sect. V) and both islands of Nova Zembla (Sect. VIII, a, b). For the mouth of the Pechora (Sect. VI) and for Vaigach Island (Sect. VII) we have no data, although it has been found breeding on the Yamal peninsula (Sect. X) by Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 323, 1912). From the mouth of the Yenisei (Sect. XI), chiefly between 71° and 73° north latitude (Tugarinow, Mess. Ornith., 1910, p. 46), as far as the regions of the north coast of the Chuckche peninsula (Sect. XXI) this Goose appears to nest in abundance. In the islands of the New Siberian archipelago (Sect. XVI) it breeds though evidently in more limited quantity, on Great Ljakoff Island (*teste* Dr. Bunge, Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 272–283, 1887), and in small numbers on Kotelny Island (noted by members of the Russian Polar Expedition), but is present in considerable force (especially on Great Ljakoff Island) in order to moult. According to the notes made by Birula (*l.c.*) and the observations of various members of the Russian Polar Expedition in 1902 and 1903, this Goose does not regularly frequent the Islands Faddejefski and New Siberia. In the Yana region (Sect. XV), according to statements obtained from the natives by Birula (1907), it breeds in very large numbers, as well as on the islands Maquar and Scheloniki, and in the tundra about Cape Swjatoi Noss. To the eastward of this promontory, in the latitudes of the Indigirka (Sect. XVIII) and the Kolyma (Sect. XIX), the White-fronted Goose is said by Roznovski (Wszechswiat, vol. 26, p. 646, 1907) to breed in the tundra, but apparently it becomes rarer on the extreme eastern parts of the Siberian coast, for the "Vega" Expedition (Palmén, Sibir. Ishk. Fogelf., p. 415, 1887) brought back but a single specimen from the north coast of the Chuckche peninsula (Sect. XXI) and was unable to confirm its breeding there. Dr. Savich (Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 26, 1927, in Russian) secured in the spring of 1915 a specimen of the White-fronted Goose at Cape Severny (Irkaipij), the culmen of which measured 47.5 mm.

The Russian Polar Expedition found this Goose for the first time and secured a single specimen 14 or 15 August 1900 in Dickson Bay (Walter, *in litt.;* Birula, 1907; Toll, 1909), but saw none at the first winter-quarters of their vessel in Western Taimyr in 1901. In 1902, Brusneff saw them near the Elijdep promontory during the spring migration and found them nesting in the Charaulach Mountains near Lake Sypygyjach as well as in the Bykow peninsula. During that summer and the summer of the preceding year, White-fronted Geese were found in rather small numbers in the vicinity of Nerpalach Bay, Kotelny Island (Birula, 1907; Dr. Katin-Jartzeff *et* Kolchak, *in litt.*) but apparently in 1903 this species was more common there and was seen by Kolchak (*in litt.*) in early summer at Cape Medweshi, and later in the vicinity of Camps Michailow and Yegorow.

As to the time of its arrival in the high latitudes of the Eurasian tundra we have only the single note of Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 227, 1853) to the effect that these birds appeared 15 June 1843 in Taimyr (Sect. XIII), latitude 74° north.

Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 323, 1912) says that heavily incubated eggs were found 19 June in the Yamal peninsula (Sect. X). Middendorff found but two eggs, 22 July in Taimyr (Sect. XIII), latitude 74° north, which evidently belonged to an incomplete and belated set. At the mouth of the Lena (Sect. XIV) young birds just hatched were recorded by Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 135, 1887) on 21 and 22 July 1884, at Sagastyr and also on Great Ljakoff Island (Sect. XVI) (*ibid.*, p. 279). A set secured 7 July 1886, contained eggs that had been incubated about ten days, that is, they had been laid about 27 June.

The moulting of this Goose took place in Taimyr (Sect. XIII) according to Middendorff (*l.c.*) between 22 July and 8 August 1843; while at the mouth of the Lena (Sect. XIV), Dr. Bunge (*l.c.*) states that the males had begun their moult 22 July 1884. On Great Ljakoff Island (Bunge, *l.c.*) the White-fronted Geese arrived in great flocks between 8 and 11 July 1886, to undergo their moult, coming not only from Cape Swjatoi Noss but also from the mouth of the Lena. By 20 July the moult is in full swing and the Geese lose their power of flight. At this time the natives regularly begin to hunt them and kill hundreds of the moulting birds.

About 24 August 1884 Dr. Bunge (*l.c.*) noticed the first preparations of the Geese for leaving the mouth of the Lena (Sect. XIV). In 1884 the migration took place between 2 and 7 September in a northwest-to-southeast direction, and the last flocks of the birds were seen 9 and 10 September. In 1886 the migration of Geese was recorded by the same observer 9 September on Great Ljakoff Island (Sect. XVI) in a north-south direction and the two last stragglers were seen 13 September.

58. **Anser erythropus** (Linné).

Anser finmarchicus Gunnerus. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, pt. 2, pp. 101, **130,** 1907.

Local names: in Russian, Yana regions, *malaja kasarka* (Little White-fronted Goose); in Yakut, *kyttáich;* in Tunguse, *njalgachjan* (Birula).

The Lesser White-fronted Goose breeds exclusively on the lakes of the alpine region of mountains and does not nest on the tundra along the coasts of the Eurasian Arctic Ocean. It has not been found either in Spitzbergen (Sect. I) or on Bear Island (Sect. II) but breeds regularly on the tops of those mountains that reach into the alpine zone in Russian Lapland (Sect. III). It has likewise been reported from the Kanin peninsula (Sect. IV) by Seebohm (Ibis, 1882, p. 385) on the basis of Henke's observations. There is some mistake in the records for Kolguev Island (Sect. V). According to all published sources and the lists of various writers, this Goose has not been found on the island and Dresser (Eggs Birds Europe, p. 538, 1910) is the only one to introduce it, evidently by mistake, into the fauna of this island, basing his statement on a communication by Buturlin, though the latter in 1901 specifically denied its presence there (App., Venery and Hunting, 1901, no. 5, p. 21). For Nova Zembla (Sect. VIII) we find a similar confusion in the works mentioned of these writers, but as an accidental visitor the Lesser White-fronted Goose really does occur there, for Professor Grigorjeff brought from Nova Zembla to our Zoölogical Museum, two heads of Geese, which I identified as belonging to *Anser erythropus* (Linné); likewise Nossilow (Tour du Monde, 1894, p. 94) includes this species among the birds of Nova Zembla, but unfortunately I am not in a position to confirm his identification as I do not know who determined the birds he collected.

The Lesser White-fronted Goose inhabits the Siberian part of the Eurasian tundra under similar conditions, that is, it nowhere reaches the coasts of the Arctic Ocean but breeds at some distance south of them in the alpine zone of mountains near that ocean. It has been reported by Buturlin (Dresser, *l.c.*, p. 538) from the lower courses of the Ob (Sect. X) and of the Yenisei (Sect. XI), from Taimyr as far north as 74° (Sect. XIII), from the regions of the mouths of the rivers Lena (Sect. XIV), Yana (Sect. XV), Indigirka (Sect. XVIII) and Kolyma (Sect. XIX), and even from the Chuckche peninsula (Sect. XXI), where, however, the "Vega" Expedition, contrary to Buturlin's statement (App., Venery and Hunting, 1901, no. 5, p. 21), did not find it. Birula (1907) says that the natives in the Yana region distinguished perfectly between the Lesser White-fronted and the White-fronted Geese; according to their statements these Geese do not occur in the islands of the New Siberian archipelago and visit the shores of the Arctic Ocean only in limited numbers to undergo their moult. Farther south at the mouth of the Yana and on the peninsulas Maquar and Scheloniki the Lesser White-fronted Goose breeds rarely.

Philacte canagica (Sevastianow).—The "Vega" Expedition found the Emperor Goose breeding rather commonly on the north coast of the Chuckche peninsula (Sect. XXI) in the vicinity of the ship's winter-quarters of 1878–79 (Palmén, Sibir. Ishk. Fogelf., p. 421, 1887). It was rediscovered in the same regions, by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 30, 1914).

Branta leucopsis (Bechstein).—*Local name* in Samoyede, *laboo* (Trevor-Battye). The Barnacle Goose breeds in Spitzbergen (Sect. I), chiefly in the northern parts of the archipelago. On the north coast of the Kola peninsula (Sect. III) it is a migrant only. Again, it has been reported as breeding in small numbers on Kolguev Island (Sect. V) by Trevor-Battye (Ice-bound on Kolguev, p. 424, 1895) but has not been found there since by a series of later investigators of the avifauna of this island, such as Pearson, Zitkow and Buturlin. In 1921 Fedosow succeeded in killing a pair of these Geese at the mouth of the Gusinaja River (The Ukraina Hunter and Fisherman, 1926, no. 7, in Russian). Nordenskiöld's supposition that the Barnacle Goose must breed in Nova Zembla (Sect. VIII) seems unlikely to me, since only Bilkiewicz (App. Mem. Exped. Sci. Univ. Kasan, p. 23, 1904) and Jordans (Journ. f. Ornith., vol. 73, p. 449, 1925) have recorded it from there. The regions of the Eurasian tundra to the eastward evidently are not inhabited by the Barnacle Goose and I feel certain that the statements made to Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 228, 1853) of their breeding in Taimyr are founded on some mistake.

59. Branta bernicla bernicla (Linné).

Bernicla brenta, Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 386, 1901. Birula, *ibid.*, p. 359, 1901. Toll, Die russ. Polarf. d. "Sarja," p. 68, 1909.

Branta bernicla (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 233, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902.

Geese, Kolomeitzeff, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 5, p. 507, 1902.

Branta bernicla bernicla (Linné). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 4–8, 100, 116, 1907.

List of Specimens from the Russian Polar Expedition.

Skin: adult female, 18 June 1901, west coast of Taimyr Strait (Dr. Walter).

Eggs: one (from the oviduct of a female) 20 June 1901; five, incubated, 8 July 1901; four, fresh, 13 July 1901; all from the west shore of Taimyr Strait (Dr. Walter).

Local names: in Samoyede, Kolguev Island, *wurrah* (Trevor-Battye); in Taimyr, *kuld* (Middendorff).

The Brant Goose nests in considerable numbers in the Spitzbergen archipelago (Sect. I), has been recorded in the migration season from Bear Island (Sect. II), along the coasts of Russian Lapland (Sect. III), and probably migrates also along the Kanin peninsula (Sect. IV) although it has not been reported from there. It breeds abundantly on Kolguev (Sect. V) and Vaigach Islands (Sect. VII). For Nova Zembla (Sect. VIII) Bilkiewicz (App. Mem. Exped. Sci. Univ. Kasan, p. 23, 1904) expresses the opinion, which seems to me perfectly probable, that the Brant crosses over the southern island and nests only on the northern one. In the Franz Josef archipelago (Sect. IX) this Goose likewise breeds regularly as well as along the shores of the Kara Sea, in the Yamal peninsula (Sect. X) and in the latitudes of the mouth of the Yenisei (Sect. XI) from 71° 5′ north latitude to the shores of the Arctic Ocean. Finally the breeding range of

this form reaches its eastern limit in Western and Eastern Taimyr (Sects. XII, XIII) because from the mouth of the Lena eastward it is replaced by the eastern race, *Branta bernicla nigricans* (Lawrence).

The Russian Polar Expedition first met with the Brant in the autumn of 1900 in Middendorff Bay; next in 1901 in the vicinity of the "Sarja's" first winter-quarters, and again near Cape Schaitanski at the mouth of the Yenisei, where the species was observed by Kolomeitzeff (*l.c.*).

The following notes are available as to the time of the arrival of this Goose in high latitudes: in Spitzbergen (Sect. I) it arrives, according to Professor König (Avif. Spitzb., p. 219, 1911) in the latter half of May and was first noted in Advent Bay on 19 May 1899 by Dittmer (Das Nord-Polarmeer, p. 225, 1901) and in Stor Fjord 29 May 1889 by Walter (Journ. f. Ornith., vol. 38, p. 243, 1890). On the Murman coast (Sect. III) Goebel (Ornith. Jahrb., vol. 12, p. 214, 1901) observed its arrival at Yeretiki, 18 May 1882; 22 May 1883; 21 May 1884; 24 May 1896; 22 May 1899; 29 May 1900. In 1883 Kriwosheja (Nature and Hunting, 1884, no. 11, p. 39) noted the first arrivals in Nova Zembla (Sect. VII) 20 May and for the Franz Josef archipelago (Sect. IX) we find in the works of Jackson (A Thousand Days in the Arctic, p. 400, 1899) and of Clarke (Ibis, 1898, p. 257) the following data: in 1882 these Geese arrived at Cape Flora in the month of June (*teste* Neale); in 1895 according to Jackson, on 8 June, and according to Koettlitz 13 June; in 1896 Jackson recorded them 3 June, Dr. Bruce on 10 June, and Dr. Koettlitz on 2 June; while in 1897 Jackson saw them first on 10 June. In Western Taimyr (Sect. XII) Walter (1902) recorded their arrival 12 June 1901 and Birula (1907) on the day following. Finally, in Eastern Taimyr (Sect. XIII) in latitude 76° 40′ north, longitude 100° 50′ east, Starokadomski (Across the Arctic Ocean, p. 66, 1916, in Russian) records their appearance in the last of May 1915.

The time of egg-laying is stated by Professor König (1911) to be normally in early June at Spitzbergen (Sect. I) but sometimes it does not take place until the end of this month. On 18 June 1908 he secured fresh eggs in Kings Bay, on 26 June on Dawn Island fresh and other eggs that were heavily incubated, while Walter (Journ. f. Ornith., vol. 38, p. 239, 1890) on 12 June 1889 found several sets of fresh eggs in the King Louis Islands and on 14 June a few eggs already slightly incubated. Römer and Schaudinn (Ornith. Monatsb., vol. 8, p. 166, 1900) secured slightly incubated eggs 23 June 1898. Kolthoff (Kongl. Svenska Vet. Akad. Handl., vol. 36, no. 9, p. 56, 1903) found both fresh and incubated eggs 27 June 1900; and Münsterhjelm (Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910) obtained more or less incubated eggs 13 June 1910.

In Birula's memoir (1907) we find the following details as to the nesting of *Branta bernicla bernicla* (Linné) in Western Taimyr (Sect. XII).

According to my observations the Brant chooses as a nesting site the elevated portions of the tundra strewn with débris of rocks and erratic boulders, and places its nest, as shown in the accompanying photographs (Pl. 27, figs. 1 and 2), at some elevation among rocks, after having first filled the space between these rocks with moss which at the same time serves as a foundation in which the nest may be hollowed out. The latter is lined abundantly with down with which the Goose also covers over the eggs on leaving the nest. One also sometimes finds Brants' nests in the wetter part near marshes but in such cases they are placed on some elevated rocks. If a man approaches, the male, who stands guard over his sitting mate, sounds a note of alarm which prompts her to leave the nest while the hunter is still a long distance away. The female leaves her nest quite unseen and endeavors to fly away close to the ground, only attaining an elevation in the air when she has gone some distance, joining her mate who stalks about on the tundra, stretching forth his neck and sounding his alarm note: *kronk-kronk*. The first set of three eggs (evidently incomplete) was found 22 June 1901.

Dr. Walter (1902 *et in litt.*) next secured a set of five incubated eggs 8 July and a third of four fresh eggs 13 July.

The egg taken by Dr. Walter (*in litt.*) from the oviduct of a female killed 20 June 1901, must be regarded as incompletely developed since it is only 69 mm. long by 45 broad, weighs only 446 cg., and still lacks the external pigmented layer. The eggs of the other two sets agree perfectly in their color and measurements with typical eggs of this Goose. They present the following dimensions and weights:

1. Five eggs, incubated, 8 July 1901, west coast of Taimyr Strait (Dr. Walter): 73 mm. x 47.6 (680 cg.); 75.2 x 47 (710 cg.); 76.5 x 47 (718 cg.); 76 x 47 (742 cg.); 76 x 48 (719 cg.).

2. Four eggs, 13 July 1901, same place and collector: 76 mm. x 47 (727 cg.); 76 x 46 (739 cg.); 73 x 47 (720 cg.); 73 x 46.5 (742 cg.).

The incubation period for eggs of this species is placed by Professor König at twenty-eight days. Newly hatched young were observed at Spitzbergen (Sect. I) by him 4 July 1908; by Münsterhjelm 6 July 1910; by Römer and Schaudinn 8 July 1898; by the Oxford Expedition 14 July 1921 (Jourdain, Ibis, 1922, p. 164); while a very late brood was seen by Zedlitz (Journ. f. Ornith., vol. 59, p. 320, 1911) 8 August 1910.

Münsterhjelm (*l.c.*) saw Brent Geese in moult at Bell Sound, Spitzbergen (Sect. I) 15 July 1910 and the Oxford Expedition at Sassen Valley 17 July 1921 (Jourdain, *l.c.*, p. 165). The moult of the Brant, as described by Birula (1907) takes place as follows:

I killed the first Brant that was flightless on account of moulting 20 July 1901; it had taken refuge in a little pond in Taimyr Strait. During my excursion with Dr. Walter in July 1901 along the shore of the Arctic Ocean to the westward of Taimyr Strait we found an immense number of Brant in moult. They occupied every little lake near the seashore, every pool that the warmer waters of the tundra had made in the ocean ice. Flocks of from ten to twenty Geese even stayed on lakes of no more than a quarter hectare in extent. Ordinarily such a flock sought its food in the tundra close at hand, but at the approach of any danger, repaired in haste to the lake and gathered in a compact group in the center of it. . . . If, after several gunshots, the Geese no longer felt secure on the lake they proceeded in column formation toward the sea and sought to reach some large pool.

At the mouth of the Kolomeitzeff River which is about a third of a kilometer across, on the approach of Birula's canoe a large number of flocks of these Geese gathered till one could not even approximately estimate how many thousands were undergoing their moult at the mouth of this river. One must suppose that similar flocks of even greater size were moulting at the mouths of other rivers and especially of Taimyr River. The moulting period of the Brant in Taimyr in latitude 76° north is more precisely defined by Birula through the following data:

The first Goose in moult was killed 20 July 1901; on 25 July we found a great flock of which but a very small part were in a condition to fly away; by 1 August out of a company of seventy Brant not one could fly, and the same was true of a flock of fifty on 5 August; on 5 and 6 August some of the Geese could already fly a little; 8 August we saw large flocks of Geese that had finished their moult; 12 August the majority of an immense company flew away at our approach though some were not yet able to fly, while by 13 August great companies of Geese were heading in the direction of the mainland and moulting birds were no longer to be seen on the lakes. In 1901 the moult of the Brant was completed in Taimyr about the 10th of August.

The departure of this Goose from Spitzbergen (Sect. I) was noted at Edge Land by Walter (*l.c.*) late in August 1889; on 26 August 1888, Pike (Chapman, Wild Norway, p. 343, 1897) observed an immense flock passing Smaerenberg Bay; 8 September 1872 their migration was seen at Green Harbor according to Eaton (Zoologist, 1874, p. 3814) and according to Cocke (Zoologist, 1884, p. 14) on 7 September 1882 at South Cape; finally Münsterhjelm (*l.c.*) noted their departure from Spitzbergen 15 September 1910. König (1911) is of the opinion that some flocks remain there for a longer time but probably keep out to sea. At Cape Flora of the Franz Josef archipelago (Sect. IX) Brant were seen by Dr. Neale 22 September 1881 (Clarke, *l.c.*), by Jackson (*l.c.*) 1 September 1895 and in the middle of August in 1896; the data for 1895 are evidently not accurate since Dr. Koettlitz (Clarke, *l.c.*) saw the last birds at the same place 1 October 1895. The Russian Polar Expedition (Walter, Toll, Birula, *ll.cc.*) met with Brant on migration in 1900 in Middendorff Bay and in 1901 were unsuccessful in fixing the date of these birds' departure from Taimyr (Sect. XII) because the vessel left these latitudes before the Geese had gone.

60. **Branta bernicla nigricans** (Lawrence).

Bernicla branta. Matiessen, Bull. Acad. Sci. St. Pétersbourg, vol. 18, no. 3, p. 65, 1903.
Brant-geese. Brusneff, *ibid.*, vol. 20, no. 5, pp. 185, 186, 192, 1904. Toll, *ibid.*, p. 158–160, 1904.
Branta bernicla nigricans (Lawrence). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 11, 13, 14, 17, 100, 122, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult male, 20 July 1902, Island of New Siberia (A. Birula); adult, 27 June 1901, Camp Wolokitin, Kotelny Island (O. Cionglinski).
Eggs: four, 6 July 1903, Faddejefski Island (S. Tolstow).

Local names: in Russian, Yana region, *njemok;* in Yakut, *kara-kas* (Black Goose) (Birula); *charcuki* (Bunge); in Tunguse, *orgö* (Birula); in Chuckche, *uedljuitti* (Palmén).

There is no doubt that the eastern form of the Brant replaces the latter along the entire coasts of the Siberian Arctic Ocean from the regions of the mouth of the Lena (Sect. XIV) to the north coast of the Chukche peninsula (Sect. XXI). The material in our Zoölogical Museum, as well as the statement of Birula (1907) that among eighty specimens examined by him, but a single one had the white collar interrupted, prove that the Brant coming from the countries mentioned belong to the eastern race. Birula (*l.c.*) is of the opinion that this Goose also inhabits the mouth of the Olenek.

The Russian Polar Expedition met with *Branta bernicla nigricans* (Lawrence) on the different islands of the New Siberian archipelago only, notably Kotelny (in 1902 by Dr. Katin-Jartzeff and Naval Lieutenant Kolchak and again by the latter in 1903), Faddejefski (Tolstow) and the Island of New Siberia (in 1902 by Birula; and in 1903, Brusneff). Finally Baron Toll (1904) saw Brant passing Bennett Island (Sect. XVII). It appears that in the New Siberian archipelago (Sect. XVI) Brant Geese nest in very limited numbers only, but that later in the season they come in great quantity to undergo their moult; these Geese frequent the most northerly islands, such as Bennett Island (Sect. XVII) and Wrangel Island (Sect. XX), for the exclusive purpose of moulting. The correctness of this supposition is shown by the following facts.

In addition to the data on their spring arrival at their breeding grounds a long list of explorers have recorded in the different parts of the range of this species, either its passage or its arrival in large flocks in the latter half of June obviously for the sole purpose of undergoing the moult in places far removed from every human habitation.

The time of their arrival in spring is indicated by the following data: (1) mouth of the Lena (Sect. XIV) (note of Dr. Bunge), the first birds were noted in 1883, 7 June and the migration was over 24 June (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 51, 1888); in 1884 the first arrivals were noted at Sagastyr 3 June and a flock was seen 11 June (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 121, 1887).

(2) On Great Ljakoff Island (Sect. XVI) (note of Dr. Bunge, *ibid.*, p. 274) these Geese arrived 10 June and 12 June 1886.

(3) On Kotelny Island (Sect. XVI), 4 June 1902, the first four birds were seen at Nerpalach; and between 3 and 8 June on the Balyktach River (Kolchak, *in litt.*). In 1903 the first flocks were noted at Cape Medweshi and at Camp Michailow 5 June and the migration lasted until 9 June (*fide* Kolchak, *in litt.*).

(4) On Faddejefski (Sect. XVI) Quartermaster Tolstow (*in litt.*) noted the arrival of Brant 6 June 1903.

(5) On the Island of New Siberia (Sect. XVI) Birula (1907) saw the first birds 2 June 1902.

(6) At Cape Severny (Irkaipij) situated between Chaun and Koljuchin Bay of the

Chuckche peninsula Dr. Savich (Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 271, 1927) noted the arrival of the Brant 2 June 1915; the majority passed between 4 and 8 June and the whole migration was over 11 June.

All these statements agree remarkably, allowing the date of arrival for the eastern form of Brant in the regions of the Lena and the Island of New Siberia to be fixed as the first week of June. The migration there does not appear to last more than about a week, confirming the view that the number of Geese that come there to nest is not great.

As to its nesting, Birula (1907) found that on the Island of New Siberia, the Brant select places for their nesting that differ considerably from those usual with the western form in Western Taimyr. In Taimyr the Brant prefer to nest in the higher parts and place their nests among erratic boulders or broken rocks that cover the ground abundantly there. In the archipelago of New Siberia on the other hand, they nest in low situations covered with standing water on the shores of rivers and lakes not far from the seacoast. Furthermore, they breed on the Koptolach-ary, the gull-island at the mouth of the Balyktach River, Kotelny Island, where in 1901, the members of the auxiliary expedition and in 1902 Kolchak found these Geese breeding and noticed that at times they take possession of old Gulls' nests, lining them with down. This islet is nothing but a sand bar thrown up at the mouth of the river and is covered by a layer of fine turf.

Egg-laying takes place in the regions mentioned during the third week of June, for the most part toward the 23d of the month. The sets found by Kolchak (*in litt.*) 17 June 1902 at Koptolach-ary, Kotelny Island, in three cases contained but a single egg, and in a fourth instance three eggs. In 1903 on Kotelny Island the same explorer did not find the first eggs until 23 June. In 1883 Dr. Bunge (1887, p. 129) found the first non-incubated eggs (collected near Kytach, at the mouth of the Lena) 22 June and on the day following near Sagastyr took a series of nests which contained respectively only one, two, and three eggs. Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 30, 1914) found on 12 July 1912, at Cape Bolschoi Baranowski, a nest in which the five young were just hatched.

The Russian Polar Expedition brought back a set of four Brant's eggs, with the following measurements and weights:

1. Four eggs, 6 July 1903, Faddejefski Island, New Siberian archipelago (S. Tolstow): 70 mm. x 48 (705 eg.); 71.2 x 48 (807 eg.); 70 x 47 (832 eg.); 69.5 x 48 (705 eg.). In coloring, the eggs of this set differ in no way from those of the western form; the abnormal weight of two of these eggs, which exceeds 800 eg., is to be explained by their incomplete preparation, for they were not wholly emptied.

We have the following data as to the moult of the eastern form of Brant:

(1) Dr. Bunge (1887, pp. 279, 280) in 1886 saw between 8 and 12 July on Great

Ljakoff Island, the migration of great flocks of these Geese all going from southeast and south-southeast to the north-northwest, probably to reach Kotelny Island. Between 13 and 16 July the Brant were going along the south coast of that island either from west to east or in the opposite direction.

(2) On Kotelny Island the Brant were gathered in considerable quantity between 18 June and 1 July 1902 on the Yelisseyefka River (noted by Kolchak, *in litt.*) and a great company was seen 4 July 1902 in the vicinity of Nerpalach by Dr. Katin-Jartzeff; in 1903 Kolchak (*in litt.*) witnessed the arrival of an immense number of these Geese 1 July 1903 near Camp Michailow.

(3) For the Island of New Siberia Birula (1907, p. 124) determined that the great bulk of these Geese did not reach there until late June or early July. In 1902 he found no nests and it was not until the following year, 1903, that Brusneff succeeded in proving that the species nests on this island.

We are thus confronted by the rather curious fact that along the northern coasts of the Siberian mainland *Branta bernicla nigricans* (Lawrence) breeds in considerable numbers but the greater part of them desert these coasts before their moulting period. On the other hand they nest in very limited numbers in the islands of the New Siberian archipelago but resort thither in great numbers by early July in order to undergo their moult.

The natives regularly begin their massacre of the Geese after St. Procopes' Day, 21 July. The appropriateness of this date was proved by Birula's observations, according to which on the Island of New Siberia, 20 July 1902, only four of a flock of some two hundred Geese were able to escape by taking to flight; the same thing is shown by the observations of Tolstow (*in litt.*) who noted that the birds were in moult 22 July 1902, on the Chukotskaja River, Kotelny Island. I should mention further the supposition of Birula that only a very few of these Geese go beyond the New Siberian archipelago in the direction of the De Long group of islands. Although in 1902 during the time of the autumnal migration this writer was encamped on the shore of Blagoweschenski Strait (Island of New Siberia), the north and south course of which makes it specially suitable for the observation of the return passage of birds from the higher latitudes, he was unsuccessful in observing the fall migration of the Brant. He saw the last Brant on this island 23 August 1902 and Brusneff observed them there up to 28 August 1903.

Rufibrenta (= **Branta**) **ruficollis** (Pallas)[1].—In August 1899, Smirnow (Nature and Hunting, 1903, no. 6, p. 16, in Russian) saw at Malijy Karmakuly, Nova Zembla (Sect. VIII), a small Goose with red neck and breast, that he believed to be a Red-necked Goose. The breeding grounds of this Goose extend to the

[1] According to Pearson (Ibis, 1896, p. 210), a native of the village Lutni on the Murman coast (Sect. III) recognizing a picture of the Red-necked Goose, told that explorer this species occasionally nests near Lake Yokanskoje. I believe that this statement is founded on some error and that the native probably had confused *Rufibrenta ruficollis* (Pallas) with *Anser erythropus* (Linné).

region of the Ob (Sect. X) where Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 325, 1912) found it and secured from the natives evidence as to its regularly breeding in these latitudes. At the mouth of the Yenisei (Sect. XI) it breeds between 70° and 74° north latitude, was found by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 229, 1853) breeding abundantly at the Pjasina (Western Taimyr, Sect. XII) in latitude 73° 40′ north and according to Tugarinow (Mess. Ornith., 1910, p. 47) nests also at the mouth of the Chatanga (Eastern Taimyr, Sect. XIII). The Russian Polar Expedition did not meet with this species.

Representatives of the subfamily Anatinae do not strictly belong to the Eurasian tundra fauna but inhabit the countries bordering on this region, occasionally appearing in it and even breeding there, so that as more or less accidental visitors they must be taken into consideration.

NOTE.—As to *Anas boschas* Linné, Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 602, 1883) makes the following remark: "An der oberen Lena, soll nach Aussage der Jakuten auch im Delta vorkommen." During his stay of two years at the mouth of the Lena, he did not observe this bird and in his later works makes no mention of it.

Mareca (=Anas) penelope (Linné).—*Local name:* in Samoyede, on Kolguev Island, *karlgar* (Trevor-Battye). The European Widgeon has been found breeding along the southern edge of the tundra on the mainland of Europe and Asia from the Murman coast (Sect. III) to the Lena delta (Sect. XIV) but has not been reported from Taimyr (Sects. XII and XIII). It breeds also on Kolguev (Sect. V) and Vaigach Islands (Sect. VII) and is of accidental occurrence on Spitzbergen (Sect. I), on Bear Island (Sect. II) (Jourdain, Ibis, 1922, p. 66) and on the southern island of Nova Zembla (Sect. VIII).

61. **Nettion (=Anas) crecca** (Linné).

List of Specimens from the Russian Polar Expedition.

Skin: adult male, 21 June 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff).

The Green-winged Teal has been found a few times on Spitzbergen (Sect. I), once on Bear Island (Sect. II), and on Nova Zembla (Sect. VIII), where Gorbunow (*in litt.*) saw a stuffed specimen, killed in 1923 at the Belushja Bay (Dauphin Bay). On the mainland it is distributed from the Murman coast (Sect. III) to the region of the Lena delta (Sect. XIV), whence the Russian Polar Expedition brought back an adult male killed by Brusneff 21 June 1902, on the Elijdep promontory. It has not been reported from either the Bolschezemelskaja tundra (Sect. VI) or from Taimyr (Sects. XII and XIII).

Nettion (=Anas) formosum (Georgi).—The Formosan Teal is of casual occurrence at the mouth of the Yenisei (Sect. XI) and on Great Ljakoff Island (Sect. XVI). It breeds regularly in the latitudes of the rivers Lena (Sect. XIV), Indigirka (Sect. XVIII) and Kolyma (Sect. XIX) and is noted by Dr. Savich (Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 35, 1927) from Cape Severny on the north coast of Chuckche Land (Sect. XXI).

NOTE.—Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 602, 1883) reported tentatively the Blue-winged Teal, *Querquedula* (=*Anas*) *querquedula* (Linné), from the Lena River system (Tasary), but since I have not been able to verify the identification I do not include this species in the list of birds from the region under consideration, and I think it probable that the specimen secured was a female of *Nettion formosum* (Georgi).

62. **Dafila (=Anas) acuta** (Linné).

List of Specimens from the Russian Polar Expedition.

Skin: adult female, 15 June 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff).

The Pintail has been recorded as an accidental visitor in Spitzbergen (Sect. I) and on Bear Island (Sect. II). It goes beyond the southern limit of the Eurasian tundra and regularly breeds in small numbers from Russian Lapland (Sect. III) to the north coast of the Chuckche peninsula (Sect. XXI). It has not been found in Eastern Taimyr (Sect. XIII) and of all the islands of the Eurasian Arctic Ocean it has been recorded only from Vaigach (Sect. VII). During the Russian Polar Expedition a flock of these ducks was seen in Middendorff Bay, Western Taimyr (Sect. XII), by Dr. Walter (*in litt.*) and a female was taken by Brusneff, 15 June 1902, on Elijdep promontory at the mouth of the Lena (Sect. XIV). Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 26, 1914) secured a young bird of this species, 27 August 1912, in Chaun Bay near Cape Shelagskoi.

Fuligula (=Nyroca) marila marila (Linné).—*Local name:* in Samoyede, on Kolguev Island, *karocerl* (Trevor-Battye). The Scaup Duck does not regularly pass beyond the northern edge of the subalpine zone but nevertheless occasionally occurs in the Eurasian tundra region from the Murman coast (Sect. III) to the mouth of the Yenisei (Sect. XI). It has also been found on Kolguev Island (Sect. V) but there are no data at hand for Vaigach Island (Sect. VII).

Fuligula (=Nyroca) marila mariloides (Vigors).—Dr. Savich (Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 35, 1927) has killed an adult male 29 June 1915 in the vicinity of Cape Severny, on the north coast of the Chuckche peninsula (Sect. XXI).

Fuligula (=Nyroca) fuligula (Linné).—The Tufted Duck is recorded as of casual occurrence on Kolguev Island (Sect. V). In addition Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 118, 1887) tells us that he found on 7 August 1885 at the mouth of the Yana, 70° north altitude (Sect. XV), a brood of very small young ones of the Pochard.

63. **Harelda (=Clangula) glacialis** (Linné).

Harelda glacialis (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 387, 1901; *ibid.*, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902. Brusneff, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 181, 1904. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 1, 2, 4–7, 9–11, 16–18, 100, **114**, 1907. Toll, Die russ. Polarf. d. "Sarja," pp. 68, 83, 347, 366, 397, 1909.

List of Specimens from the Russian Polar Expedition.

Skin: adult male, 17 June 1902, Elijdep promontory, Charaulach Mountains, mouth of the Lena (M. Brusneff).

Nest and eggs: a nest with one egg, 22 June 1903, Tiksi Bay, Bykow peninsula, mouth of the Lena (Th. Matiessen).

Local names: in Russian, Yana region, *savka* (Birula); in Samoyede, Kolguev Island, *a-où* (*a-oô* according to Trevor-Battye's transcription); in Yakut, *angà* (Bunge, Birula); in Tunguse, *aujeldý* (Birula); in Chuckche, *pojgachek* (male), *achak* (female) (Palmén).

The Long-tailed Duck is the commonest of all the Anatidae and the most widely distributed along the coasts of the Eurasian Arctic Ocean. I may refrain from listing the occurrences of this Duck in the various sections of the region under consideration and confine myself to stating only those in which it has not been found and to reviewing the circumstances under which it occurs in some of these sections.

It has not been found in the Franz Josef archipelago (Sect. IX) but occurs on Wrangel Island (Sect. XX, a), while for Herald Island (Sect. XX, b) we have no record of its presence.

The Russian Polar Expedition (see Walter, Birula, Toll) found the Long-tailed Duck from the time it entered the Kara Sea, after passing Jugor Strait (Sect. X). Great flocks were noted in the Western Taimyr region (Sect. XII) (Middendorff and Minin Bays) between 25 August and 17 September 1900. In 1901 it was a rather common species in the vicinity of the "Sarja's" first winter-quarters. For several weeks after their arrival the Long-tailed Ducks kept to the lakes and pools of the tundra and in early July flocks of them sought the nearby parts of the Arctic Ocean that were free of ice. These flocks consisted chiefly of males. Neither Dr. Walter nor Birula succeeded in discovering any nests of this species, which prompted the latter to suggest that even if it nests on the coasts of Western Taimyr, it must do so in very small numbers only. The same conditions appeared in 1902 and 1903 in the New Siberian archipelago (Sect. XVI). Although the Long-tailed Duck was noted on nearly all the islands of the archipelago, not a set of eggs or a brood of young could be found there. Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 276, *et seq.*, 1887) records this species from Great Ljakoff Island. On Bielkovski Island Matiessen and Kolchak (*in litt.*) found great companies of these birds. On Kotelny Island, according to Dr. Katin-Jartzeff's (*in litt.*) observations, they kept to the lakes of the western promontory in early July, and on 13 July were noted on the blocks of ice in the sea. Kolchak (*in litt.*), who saw this duck in a number of places on Kotelny Island, for example at Camp Michailow, near Medweshi promontory and in the neighborhood of the Balyktach River, lays stress on the fact that neither in 1902 nor in 1903 was he able to find any evidence that this Duck breeds on Kotelny Island. He therefore suggests that it apparently nests in the northern parts of the island. On Faddejefski Island both S. Tolstow (*in litt.*) and Brusneff (1904) record great flocks of these birds. On the Island of New Siberia in late May 1902 according to Birula (1907) Long-tailed Ducks were flying along Blagowestchenski Strait coming from the mainland to the open waters farther north and returning again to the mainland. After 5 July flocks of these Ducks appeared on the tundra lakes in the interior of the Island of New Siberia, but after the ocean became clear of ice, which took place about the end of July, they sought the open sea. During

his stay on this island in 1902, Birula was again unsuccessful in establishing the breeding of this species.

Taking into consideration the fact that the Long-tailed Duck nests in very considerable numbers on the Eurasian mainland from the Murman coast on the west to the north coast of the Chuckche peninsula on the east, we are forced to the conclusion that the breeding range of this species lies a little farther south at the limits of the subalpine zone. If this supposition be correct, it is clear that the Long-tailed Duck nests in the typical tundra only exceptionally and in relatively small numbers and that the flocks of these birds observed in mid-July are chiefly composed of males that have deserted their breeding grounds immediately after the females have begun to incubate and betaken themselves to the shores of the Arctic Ocean where food is more abundant and varied.

The Long-tailed Duck was also found by the Russian Polar Expedition 12 September 1901 in the latitudes of Bennett Island (Sect. XVII) and by the auxiliary expedition under Brusneff it was discovered nesting at the mouth of the Lena (Sect. XIV). Information obtained from the natives by Birula indicated that it breeds abundantly in the regions of the mouth of the Yana (Sect. XV), for example along the Muksusnovka River. His notes state that at their moulting season the birds gather into flocks numbering from five to six hundred individuals in the region of Cape Swjatoi Noss, especially on the Lake and the River Yurun-ulach.

In Spitzbergen (Sect. I) the Long-tails appeared in 1861 on Danes Island 28 May (Malmgren, Journ. f. Ornith., vol. 11, p. 379, 1863); in 1889 in Edge Land according to Pike (Chapman, Wild Norway, p. 350, 1897; Walter, Journ. f. Ornith., vol. 38, p. 243, 1890) on 29 May; in Nova Zembla (Sect. XIII) large flocks were observed 11 June 1903 (Schaanning, Bergens Mus. Aarb., 1907, no. 8, p. 83); and at the "Sarja's" first winter-quarters in Western Taimyr (Sect. XII) (Walter, *in litt.*; Birula, *l.c.*) 13 June 1901. They were seen by Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 236, 1853) on the Taimyr River in latitude 74° north on 17 May 1843; and finally Birula (1907) noted the arrival of the first solitary bird on the west coast of Kotelny Island (Sect. XVI) on 11 May 1902.

Data on the periods of the nesting phenomena are very few and permit of only a few general conclusions. In Spitzbergen (Sect. I) Professor König (Avif. Spitzb., p. 227, 1911) states that egg-laying begins toward the end of June and takes place chiefly in the first part of July. The Oxford Expedition (Jourdain, Ibis, 1922, p. 166) secured a set of six heavily incubated eggs 12 July 1921 at Cape Boheman. Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130, 1903, in Russian) found fresh sets of eggs in Russian Lapland (Sect. III) in the region of the Pasvig River between 15 and 27 June, fresh eggs in the western part of the Murman coast on 1 July, and young birds between 22 July

and 1 August. On Kolguev Island (Sect. V) Trevor-Battye (Ice-bound on Kolguev, p. 427, 1895) found a set of six eggs 27 June and according to Tolmacheff (*in litt.*) a nest 27 July contained six young in down, and a young bird secured 14 August was covered with feathers but could not fly. Schaanning (*l.c.*) saw newly hatched young at Matochkin-shar, Nova Zembla (Sect. VIII), on 23 and 27 August 1903; in 1923 according to Gorbunow (*in litt.*) the young birds on 21 August were in part unable to fly. Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 132-133, 1887) on 29 June took an incomplete set of two eggs and on 4–6 July 1884, another set of five eggs at Sagastyr, at the mouth of the Lena (Sect. XIV). The nest with a single egg taken by Naval Lieutenant Th. Matiessen 22 June 1903 in the vicinity of Tiksi Bay on the Bykow peninsula, comes from the same section. This egg measures 53.5 mm. x 37.2. The weight of the shell could not be determined as the egg was imperfectly blown.

The moulting period of the Long-tailed Duck begins in Spitzbergen in early August for Birula (Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 169, 1910) secured a specimen 7 August 1899, that was unable to fly. In Nova Zembla according to Bilkiewicz (App. Mem. Exped. Univ. Kasan, p. 22, 1904) moulting takes place in late July, while Baron Toll (1909, p. 366) saw flocks of moulting Long-tailed Ducks in Western Taimyr 21 August 1901.

The departure of the last Long-tails was noted in Spitzbergen (Sect. I) by Dr. Bunge (Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 307, 1902) on 15 October 1899 and by A. Pike (Chapman, Wild Norway, p. 344, 1897) on 5 October 1887. In Nova Zembla (Sect. VIII), Bilkiewicz states that the greater part of these birds had flown by 23 September and that single individuals remained there until 27 September 1904. According to Schaanning they remained in 1903 at Matochkin-shar until 18 November. At Golchiha, at the mouth of the Yenisei (Sect. XI) these Ducks left, according to Miss Haviland (Ibis, 1915, p. 398), in mid-September 1914. In 1900 the Russian Polar Expedition noted the last Long-tailed Ducks in Middendorff Bay, Western Taimyr (Sect. XII) 14 September and at the mouth of the Yana (Sect. XV) Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 118, 1887) observed the last ones 19 September. In 1901, Birula on 10 October in the latitudes of Kotelny Island saw three birds on their way southward, while in 1902 he noted the last flock on the Island of New Siberia 14 September and in 1903 Naval Lieutenant Kolchak recorded the last flock at Cape Medweshi, Kotelny Island, on 30 September.

Histrionicus histrionicus histrionicus (Linné).—The Harlequin Duck was recorded on the Murman coast (Sect. III) according to Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122-123, 1903; Ornith. Jahrb., vol. 12, p. 215, 1901) 12 May 1900 at Yeretiki and in the winter of 1900-01 at Alexandrovsk. In mentioning these records I feel that I should express some doubt as to the correct identification of the species in question especially if the records do not refer to adult males in breeding dress.

The Hydrographic Expedition to the Arctic Ocean brought back a specimen of this Duck killed in Dickson Bay, at the mouth of the Yenisei (Sect. XI).

Oidemia fusca fusca (Linné).—The Common Scoter nests along the coasts of the Eurasian Arctic Ocean from the Murman coast (Sect. III) to the Yenisei delta (Sect. XI) as well as on Kolguev Island (Sect. V), Vaigach Island (Sect. VII) and the south island of Nova Zembla (Sect. VIII, a). In Spitzbergen (Sect. I) this bird has been several times reported, but in 1911 Professor König (Avif. Spitzb., p. 232, 1911) nevertheless expressed his doubts as to its occurrence in this archipelago. These doubts have now been cleared away by Mathey-Dupraz (Bull. Soc. Sci. Nat. Neuchâtel, vol. 38, p. 47, 1911) who on 18 July 1906 succeeded in collecting a male and a female of this species in Research Bay and a third specimen 2 August 1906 in Advent Bay. The Russian Polar Expedition did not meet with this Duck.

Oidemia fusca stejnegeri (Ridgway).—The Pacific form of the Common Scoter has been recorded for the Siberian coast of the Arctic Ocean in the region of the Chatanga, Eastern Taimyr (Sect. XIII) where Tolmacheff's expedition secured an adult male for the Zoölogical Museum of the Academy of Sciences. Buturlin (Venery and Hunting, 1906, no. 12, p. 13) is undoubtedly quite correct in referring the Scoters of the mouth of the Kolyma (Sect. XIX) to the American subspecies, although he had no opportunity actually to identify specimens; for the specimens of *Oidemia stejnegeri* (Ridgway) secured by Czerski in the Kolyma river-system (near Verchne Kolymsk) prove the correctness of his supposition. Nelson (Cruise of the Corwin, p. 102, 1883) referred the many Scoters he saw 7 August 1881 on the rocks of Cape Vankarema (Sect. XXI) to *Melanitta fusca* (Linné) but obviously they must likewise be regarded as belonging to the American form. The Russian Polar Expedition nowhere met with the Pacific race.

Oidemia nigra nigra (Linné).—*Local name:* in Samoyede (Vaigach Island), *liëglevia* (von Heuglin). The Black Scoter inhabits nearly the same regions as the Common Scoter. It is more common in Spitzbergen (Sect. I) and has been found to nest there on Training-Squadron Island (König, Avif. Spitzb., p. 231, 1911). Further, it has been noted by Professor König (*l.c.*) during the years 1907 and 1908 on Bear Island (Sect. II) and apparently bred there; finally, its range extends farther eastward in Siberia to include Taimyr (Sect. XII). The Russian Polar Expedition, however, did not detect it in the neighborhood of the "Sarja's" first winter-quarters, which is probably to be accounted for by the fact that it does not reach such high latitudes.

I hesitate to say definitely which of the two forms, *Oidemia nigra nigra* (Linné) or *Oidemia n. americana* (Swainson and Richardson), inhabits the Lena delta. According to Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 51, 1883) it is the European race, but Buturlin (in Dresser, Eggs Birds Europe, p. 579, 1910) says the American subspecies occurs there rarely. For my part I favor the latter view. This subspecies was nowhere found by the Russian Polar Expedition.

Oidemia nigra americana (Swainson and Richardson).—The American Black Scoter is found not only in America but in eastern Siberia as well, and although it probably nests chiefly in the wooded portions (*Regio sylvatica*) it appears also in various parts of the Siberian coast of the Arctic Ocean. Buturlin (in Dresser, Eggs Birds Europe, p. 579, 1910) states that it occurs in the Lena delta (Sect. XIV), more regularly at the mouths of the Yana (Sect. XV), the Indigirka (Sect. XVIII) and the Kolyma (Sect. XIX) (Buturlin, Venery and Hunting, 1906, no. 12, p. 13). The Russian Polar Expedition did not have an opportunity to meet with this subspecies.

Pelionetta (=Oidemia) perspicillata (Linné).—It is only Nelson (Cruise of the Corwin, p. 102, 1883) who claims to have observed a Surf Scoter 1 August 1881 on the rocks of Cape Vankarema, on the northern coast of the Chukche peninsula (Sect. XXI).

64. Heniconetta (=Polysticta) stelleri (Pallas).

Heniconetta stelleri (Pallas). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 5–6, 13, 100, 113, 1907.

Somateria stelleri (Pallas). Toll, Die russ. Polarf. d. "Sarja," p. 523, 1909.

List of Specimens from the Russian Polar Expedition

Skins: adult male, 2 July 1901, west coast of Taimyr Strait (Dr. Walter); adult male, 18 June 1902, Nerpalach Bay, Kotelny Island (Dr. Katin-Jartzeff); adult female, 7 July 1902, Island of New Siberia (A. Birula); adult male, 23 June 1901, adult female, 3 July 1901, adult male, 3 July 1901, adult female, 10 August 1901, all from Camp Michailow, Kotelny Island (O. Cionglinski).
Skeletons: two, 1902 (A. Birula); one, 1903 (M. Brusneff), from Island of New Siberia.

Local names: in Yakut, region of the Yana, *birginjak* (Birula, Toll), *sirjgynjach* or *äbios* (Bunge); in Tunguse, *tybinder* (Birula); in Chuckche, *kataadlin* (Palmén).

It seems to me that the conditions under which Steller's Eider occurs in the northern parts of the Eurasian mainland are quite the same as those given for the Long-tailed Duck. The breeding grounds lie at some distance from the shores of the Arctic Ocean, from the Murman coast (Sect. III) to the north coast of the Chuckche peninsula (Sect. XXI), while flocks consisting of male birds and in part of females not breeding during that particular year frequent the more northern parts of the Arctic Ocean where it is free of ice. Along the Murman coast (Sect. III) this Eider is regularly to be found in the Arctic Ocean during the whole year and a certain proportion breed undoubtedly in these latitudes. In my former work upon the birds of Russian Lapland (Pleske, Krit. Übers. d. Säug. u. Vögel der Kola-Halbinsel, Beitr. Kenntn. Russ. Reichs, ser. 2, vol. 9, pt. 2, p. 276-283, 1886) I have brought forward all the arguments *pro* and *contra* the view expressed and have pronounced myself in favor of the nesting of the species in Russian Lapland. Middendorff, Malm, Schrader, Nordvi, Heuglin, Collett, Smith and myself sustained the opinion that Steller's Eider does breed in the western part of the Murman coast, in the vicinity of the Rybachi peninsula and the Pasvig-elf. On the other hand Meves, Palmén and Mela denied their breeding there and based their opinion upon the fact that Nordvi has sold to different oölogists eggs of Steller's Eider from the Murman coast, which in reality belong partially to *Harelda glacialis*. But I have had the satisfaction to receive from one of my opponents, the late Professor Palmén, a letter in which he informed me that the Finnish Scientific Expedition to Russian Lapland, which he conducted, has had the good fortune to obtain proofs of the nesting there of Steller's Eider. More recently Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903; Ornith. Jahrb., vol. 13, p. 114–115, 1902) noted its breeding near the Rybachi peninsula and on the mainland portion of Kola Bay. I was therefore much astonished to find in the Ibis of 1926 and 1927 polemics upon the question of the nesting of Steller's Eider on the Kola peninsula especially since the objections are based upon the same statements of Nordvi, which I forty years ago have cleared up. Bolam (Ibis, 1926, p. 440–441) found 15 July 1924 near the Varanger Fjord in a large inland lake a Duck of this species accompanied by nine young a day or two old and on the following day five Ducks. The Rev. Jourdain (Ibis, 1926, p. 832-833) and Bunyard (Ibis, 1927,

p. 177–178) denied the possibility of the nesting of this species in Lapland, the first basing his opinion upon the sale by Nordvi of unsatisfactorily determined eggs belonging to the Long-tailed Duck and the second relying on the fact that Mr. Hilge Lillienstierna during over eight years' living on the Pasvig River has not had an opportunity to detect cases of Steller's Eider breeding there. Again, this species was found as a casual visitor in the south island of Nova Zembla (Sect. VIII, a) by Bilkiewicz (App. Mem. Exped. Univ. Kasan, p. 22, 1904) and as a regular breeding bird in the Yamal peninsula (Sect. X) by Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 328, 1912).

The Russian Polar Expedition did not succeed in finding this Eider breeding in the parts of Western Taimyr (Sect. XII) visited (Walter, 1902, *et in litt.;* Birula, 1907), but Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 234, 1853) had the good fortune to discover a set of fresh eggs there 8 July. In Eastern Taimyr (Sect. XIII) the Hydrographic Expedition to the Arctic Ocean collected a specimen of this Duck in Dick Bay, north latitude 76° 48′, east longitude 100° 50′. In the region of the Lena delta (Sect. XIV) it breeds abundantly according to the observations of Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 12, p. 53, 1888; Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 132, 1887), as well as at the mouth of the Yana (Sect. XV) as appears from the statements of Birula (1907). The natives report that nests are very numerous along the rivers Muksunovka, Syaalach, at the mouths of the Yana and the Omoloi and even on some of the lakes of the tundra bordering the Yana, and on the islands Scheloniki and Maquar. In the New Siberian archipelago (Sect. XVI), Steller's Eider, according to the natives (Birula, 1907), is only a rare breeder in the groups of the Nearer and even the Farther Islands. Its nesting in this archipelago was not certainly established by the Russian Polar Expedition but is very probable, because Quartermaster S. Tolstow (*in litt.*) while dissecting female birds killed in 1903 on Faddejefski Island, found in some of them eggs which still lacked shells. On Kotelny Island, Dr. Katin-Jartzeff secured an adult male, 18 June 1902, in the vicinity of Nerpalach Bay, O. Cionglinski of the auxiliary expedition collected two pairs (specimens in the collection) at Camp Michailow in 1901 and Naval Lieutenant A. Kolchak (*in litt.*) found it in early summer of 1903 at Cape Medweshi and again at Camp Michailow and in great abundance at Camp Yegorow. Steller's Eider likewise breeds in the deltas of the Indigirka (Sect. XVIII) and the Kolyma (Sect. XIX), nests in great quantities on the north coast of the Chuckche peninsula (Sect. XXI) and has been found in the latitudes of Wrangel (Sect. XX, a) and Herald (Sect. XX, b) Islands.

Egg-laying takes place in the first part of July. Thus Middendorff found a set of fresh eggs 7 July 1843 in Taimyr and Dr. Bunge took two incomplete sets containing but two eggs each at Sagastyr, in the Lena delta, on 2 July and between 4 and 6 July 1884.

65. **Arctonetta fischeri** (Brandt).

Somateria fischeri Brandt. Brusneff, Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 185, 1904. Toll, Die russ. Polarf. d. "Sarja," p. 523, 1909.

Arctonetta fischeri (Brandt). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 11–12, 14, 100, 111, 1907.

List of Specimens from the Russian Polar Expedition.

Skin: adult female, 22 June 1903, Roshin promontory, Island of New Siberia (M. Brusneff).
Eggs: four, no data (probably received from the natives) (Dr. Katin-Jartzeff).

Local names: in Yakut and Tungusc, in the latitudes of the Yana, *dulkjan* (Birula, Toll); in Chukche, *lilekedlin* (Palmén).

Fischer's Eider breeds regularly in northern Siberia, probably at some distance from the shores of the Arctic Ocean, from the region of the Lena (Sect. XIV) to the north coast of the Chukche peninsula (Sect. XXI). It is of occasional occurrence in the islands of the New Siberian archipelago (Sect. XVI) but it is not certainly known to breed there. One of the natives who was with Birula (1907) during his stay on the Island of New Siberia, the Lamut Stepan Sergeyeff, found nests of this Eider in the Bykow branch of the Lena River (Sect. XIV); the same native also told him that he had on a few occasions taken nests of this Duck on islands of the lakes in the Yana region (Sect. XV) along the limit of the forest. According to the evidence secured by Birula, Fischer's Eider must nest at the mouths of the rivers Yana and Syalach, on the Muksunovka River and generally in the tundra about Cape Swjatoi Noss. Its nesting in the latitudes of the mouths of the Alaseja and the Indigirka (Sect. XVIII) is proved by the discoveries of H. Roznovski, a collaborator with Buturlin (see Buturlin, Journ. f. Ornith., vol. 56, p. 285, 1908; Dresser, Bull. Brit. Ornith. Club, vol. 23, p. 39, 1908) as well as by Sensinow (Zitkow and Sensinow, Journ. Zool. Sec. Friends Nat. Sci., Anthrop. and Ethnogr., new ser., vol. 3, no. 2, p. 13, 1915). At the mouth of the Kolyma (Sect. XIX) Buturlin (Venery and Hunting, 1906, no. 12, p. 13; Journ. f. Ornith., vol. 56, p. 128, 1908) succeeded in finding this species nesting while in the neighborhood of the "Vega's" winter-quarters of 1878–79, on the north coast of the Chukche peninsula (Sect. XXI), the members of that Expedition secured a considerable series of specimens of this species. They did not, however, succeed in obtaining sets of eggs, but Professor Palmén (Sibir. Ishk. Fogelf., p. 439, 1887) states his belief that this Duck must nest in the region on account of its abundance during the breeding season. This conviction was later substantiated by the discoveries of Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 27, 1914) at Cape Baranovski and especially on the Tenkurgin River.

Previous to the Russian Polar Expedition, the late Baron Toll was the only one who had obtained (in 1893) a good specimen of this species on Great Ljakoff Island (Sect. XVI) (specimen in our Zoölogical Musuem; Birula, 1907). At all events Dr. Bunge

does not list it for Great Ljakoff Island and the natives who regularly come to this archipelago to hunt for fossil ivory were unanimous in assuring Birula that the *dulkjan* never frequents Ljakoff, Kotelny and Faddejefski Islands and that no one ever had seen it there. That this assertion is not correct is perhaps indicated by the fact that Naval Lieutenant A. Kolchak (*in litt.*) during his journey to Faddejefski Island, saw on 16 June, two Eiders that his native companions called *dulkjan*. On the Island of New Siberia, Fischer's Eider was seen in 1901 by the auxiliary expedition under Wolosowicz (Birula, 1907). In 1902, Birula (1907) himself several times noted the presence of one or several pairs of these birds on the seacoasts of this island. Before the sea ice melted they at times frequented the borders of some stream close to the sea but with the breaking up of the ice they sought the open ocean. Birula was unsuccessful in discovering the slightest evidence of their breeding and expressed his conviction that even if this species does nest there, it does so altogether casually. In 1903, Brusneff was so fortunate as to secure, 22 June, an adult female at Cape Roshin, on the Island of New Siberia.

I must here mention the fact that Dr. Katin-Jartzeff secured for our Zoölogical Museum the remains of four eggs of unknown origin, but probably received from one of the natives. These eggs must have been heavily incubated for in order to remove the embryos nearly a fifth part of the large end of each egg had been removed which makes it impossible to give the dimensions and weights of the shells of these very rare eggs. A comparison of these fragments with authentic eggs of *Arctonetta fischeri* (Brandt) has nevertheless convinced me that they belong unquestionably to this species.

Somateria mollissima borealis (Brehm).—I feel that I must completely endorse the view expressed by Professor König and Dr. le Roi (Avif. Spitzb., p. 233, 1911; Ornith. Monatsb., 1912, pp. 65, 66) as to the identity of the Greenland Eider, *Somateria mollissima borealis* (Brehm) with the Spitzbergen Eider, *Somateria mollissima thulensis* Malmgren. In the Eurasian tundra region this western form occurs in considerable numbers in the Spitzbergen archipelago (Sect. I) and in much more limited numbers on Bear Island (Sect. II). An Eider breeds also rather commonly in the Franz Josef archipelago (Sect. IX), but it is still an open question whether this colony belongs to the western race or to the typical form. Professor Palmén (Wright and Palmén, Finl. Fogl., p. 438b, 1873) is of the opinion that *Somateria mollissima borealis* (Brehm) visits the coasts of Finmark and Russian Lapland to winter.

Somateria mollissima mollissima (Linné).—The Common Eider frequents the northern coasts of the Eurasian Arctic Ocean from the Murman coast (Sect. III) to the mouth of the Yenisei (Sect. XI) and the islands of the western part of this ocean with the exception of Spitzbergen (Sect. I) and Bear Island (Sect. II). It winters in the vicinity of its breeding grounds when it finds areas of open water and in such places is almost non-migratory. Nevertheless it may be that the Eiders of the Murman coast (Sect. III) leave these latitudes and pass the winter on the Norwegian coasts of the Atlantic and are replaced by birds coming from Nova Zembla or the coasts of the Kara Sea. Although Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 120–121, 1903, in Russian) regards the Common Eider as a resident species in the western part of the Murman coast and Kola Bay, he gives us in another paper (Ornith. Jahrb., vol. 12, p. 215, 1901) the following dates of its arrival at Yeretiki: 26 April 1882; 20 April 1884; 18 March 1896; 9 May 1899; 24 March 1901. This to a certain degree confirms the correctness of my view, expressed above. The Common Eider also breeds on Kolguev Island (Sect. V),

Vaigach Island (Sect. VII), the two entire islands of Nova Zembla (Sect. VIII, a and b) and in rather considerable numbers even in the Franz Josef archipelago (Sect. IX); at the mouth of the Yenisei it has been found by Popham near Golchiha (Ibis, 1898, p. 511).

The arrival of the Common Eider in "Goose Land," Nova Zembla, was noted by Krivosheja (Nature and Hunting, 1884, no. 11, p. 39) on 4 April 1883, by Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 35) at Matochkin-shar, on 11 June 1903, and at Cape Flora in the Franz Josef archipelago on 24 June 1895, and 28 May 1896 (Clarke, Ibis, 1898, p. 258; Jackson, A Thousand Days in the Arctic, p. 400, 1899).

Goebel (1903) found sets of fresh eggs between 2 June and 6 July in the western part of the Murman coast, and young in down 11 July. Bilkiewicz (App. Mem. Exp. Univ. Kasan, p. 21, 1904) procured a set of seven heavily incubated eggs in Nova Zembla 27 July and noted a great number of downy young by early August. Schaanning in 1903 found fourteen sets in the vicinity of Matochkin-shar, the first eggs of which were laid between 2 and 17 July. According to Gorbunow (*in litt.*) 29 August 1923, at Malijy Karmakuly not all the young birds were able to fly; in 1925 the males had not changed nuptial dress until 7 August (on Belushja (Dauphin) Bay); on 19 September 1925 he observed at Petuchovski-shar big young birds partially in down. A nest found 7 July 1897 at Cape Mary Harmsworth, in the Franz Josef archipelago, contained two young birds and an egg from which the chick was beginning to hatch (Clarke, *l.c.*)

As to dates for the Common Eider's departure from its far northern breeding grounds, we have the following: according to Bilkiewicz (*l.c.*) the majority leave Nova Zembla immediately after moulting is completed, that is, by early September; the last birds disappeared by 3 October. Gorbunow (*in litt.*) observed adult and young birds in 1923 at Malijy Karmakuly until 2 October. At Cape Flora in the Franz Josef archipelago (Clarke, *l.c.*) the last individuals were noted 22 September 1881.

Somateria mollissima v-nigrum Gray.—*Local names:* in Chukche, *kupuken* (male), *emngi* (female) (Palmén). The Pacific form of the Common Eider was not met with by the Russian Polar Expedition, for in Asia this species occurs only on the north coasts of the Chukche peninsula (Sect. XXI). Here several pairs were found by Nelson (Cruise of the Corwin, p. 101, 1883) in the neighborhood of Cape Deshneff, and in considerable quantities at Cape Vankarema though they were much less common than *Erionetta* (=*Somateria*) *spectabilis* (Linné) and *Henriconetta* (=*Polysticta*) *stelleri* (Pallas). Next, the "Vega" Expedition (Palmén, Sibir. Ishk. Fogelf., p. 444, 1887) found it breeding in the region of the vessel's winter-quarters, in 1878–79. Koren's expedition (Thayer and Bangs, Proc. New England Zool. Club, vol. 5, p. 28, 1914) found it along the north coast of Siberia between Bering Strait and Ajan Island in Chaun Bay (Sects. XXI, XIX). The Russian Hydrographic Expedition to the Arctic Ocean brought back some twenty specimens, some of which came from the north coasts of the Chukche peninsula and finally Dr. Savich (Artobolewski, Mem. Kiev. Soc. Nat., vol. 27, p. 36, 1927) found it abundantly in the vicinity of Cape Severny. In addition to these localities, Buturlin (Journ. f. Ornith., vol. 56, p. 293, 1908) records it from the mouth of the Lena (Sect. XIV), though I am inclined to think that probably these could have been only a few stragglers.

66. Erionetta (=Somateria) spectabilis (Linné).

Somateria spectabilis (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 232, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902. Matiessen, Bull. Acad. Sci. St. Pétersbourg, vol. 18, no. 3, p. 65, 1903. Brusneff, *ibid.*, vol. 20, no. 5, pp. 181, 185, 1904.

Erionetta spectabilis (Linné). Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, p. 5–16, 18, 100, 101, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult female, 16 July 1901, adult male, no date, from west coast of Taimyr Strait (Dr. Walter); adult female, 15 May 1902, adult female, 22 June 1902, female, 3 July 1902, four young in down, 15

July 1902, all from Nerpalach, Kotelny Island (Dr. Katin-Jartzeff); two adult males, 27 June 1901, Camp Wolokitin, Kotelny Island (O. Cionglinski); adult male, 22 June 1903, Roshin promontory, Island of New Siberia (M. Brusneff).

In alcohol: one head, 30 June 1902, Island of New Siberia (A. Birula).

Eggs: five, 6 July 1901, west shore of Taimyr Strait (Dr. Walter); four (of seven), 15 June 1902, Nerpalach, Kotelny Island (Dr. Katin-Jartzeff); six, 30 June 1902, Island of New Siberia.

Local names: in Samoyede, Kolguev Island, *namatur* (Trevor-Battye); in Taimyr River, *totynne* (Middendorff); in Russian and in Yakut in the latitudes of the Yana, *turkan;* in Tunguse, *jongulga* (Birula); in Chuckche, *jekadlin* (Palmén).

The King Eider is widely distributed along the entire extent of the Eurasian Arctic Ocean from Spitzbergen (Sect. I) to the north coast of the Chuckche peninsula (Sect. XXI) and we lack data only for Herald Island (Sect. XX). In first instance we must call the reader's attention to the fact that this species breeds chiefly in the northern parts of the Eurasian tundra. Thus in Spitzbergen (Sect. I) according to Schalow (Fauna der Arktis, p. 166, 1905), this species is more numerous in the northern parts of the archipelago, and on Bear Island (Sect. II) according to König (Avif. Spitzb., p. 243, 1911) it occasionally appears, probably in the migration season, but does not nest there. On the Murman coast (Sect. III) it does not breed regularly but is a common migrant in autumn, winter and spring, while instances of its nesting there can only be altogether exceptional. In the sections including the Kanin peninsula (Sect. IV) and the regions of the mouth of the Pechora (Sect. VI) it must breed in very small numbers, but in winter is of regular occurrence offshore, if the sea is not completely frozen over. In the islands and archipelagoes of the Barenz Sea, Kolguev Island (Sect. V) and Vaigach Island (Sect. VII), the two islands of Nova Zembla (Sect. VIII) and the Franz Josef archipelago (Sect. IX), the King Eider breeds in considerable numbers as well as along all the coasts of the Siberian Arctic Ocean and on most of the nearby islands. Yet it is clear that the numbers breeding on the mainland are fewer and that it is chiefly the islands of the Arctic Ocean, notably the New Siberian archipelago, that attract this Duck through the occurrence of open areas of ocean in these latitudes at a much earlier season.

The Russian Polar Expedition found this species in the Kara Sea (Sect. X) and established the fact of its breeding in 1901 in the neighborhood of the "Sarja's" first winter-quarters in Western Taimyr (Sect. XII) (Walter, 1902, *et in litt.;* Birula, 1907). Again, it was observed 12 September 1901, in the latitudes of Bennett Island (Sect. XVII) (Birula, 1907) and in great abundance in 1902 and 1903 on all the islands of the New Siberian archipelago. Naval Lieutenant Kolchak (*in litt.*) saw it 4 June 1903 between Little Ljakoff and Kotelny Island; Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 274, 1887) had already recorded it in 1886 on Great Ljakoff Island and had found a female, dead but still warm, in Bielkovski Strait; lastly Naval Lieutenant Matiessen (1903) saw numerous flocks along the south coasts of the island bearing the same name.

In 1902 and 1903, the King Eider was very common in all parts of the islands: Kotelny (1902—Dr. Katin-Jartzeff, *in litt.;* 1903—Kolchak, *in litt.*); Faddejefski (1902—Birula, (1907); and 1903—Tolstow, *in litt.*); and New Siberia (1902—Birula; Brusneff, 1904).

As to the arrival of the King Eider in the far north, Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 84) records its appearance in numbers at Matochkin-shar, Nova Zembla, 26 June 1903. But above all, the members of the Russian Polar Expedition have brought back some very peculiar and interesting notes. In Western Taimyr this species was for the first time encountered 23 June 1901 but neither Dr. Walter (1902, *et in litt.*) nor Birula (1907) could see any migration of flocks of these Eiders; it was obvious that in Taimyr it had reached the northern limit of its breeding area and did not pass farther northward than this. Likewise, Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 233, 1853) did not observe the arrival of these birds on the Taimyr River, 73° 45′ north latitude, until 28 June.

Quite otherwise was the picture of their arrival in 1902 and 1903 at the New Siberian archipelago. During his journey along the south coast of Kotelny and Faddejefski Islands to reach the Island of New Siberia, Birula had an opportunity to see numerous flocks of these birds, some passing northward and others to the south. He also found a certain number of dead birds that had succumbed to the fatigue of their journey. He gives us the following account of his observations on this matter:

On 3 May I saw a flock of 70–80 King Eiders going north in Durnowskaja Bay (west coast of Kotelny Island).

At Cape Krestovy, west coast of Kotelny Island, a female was found dead on the ice 12 May.

On 14 May, near Camp Yegorow, southwest coast of Kotelny Island, a female exhausted by its journey and the cold, was killed on the ice. The same day a male still alive was captured near Camp Michailow (southern part of Kotelny Island) and 15 May, a male exhausted from fatigue was taken at Nerpalach (Dr. Katin-Jartzeff).

On 19 May, immense flocks, comprising hundreds of birds, going north-northwestward were noted during the night on the south coast of Bunge Land.

On 21 May, in the vicinity of Korga, south coast of Bunge Land, we saw during the day an enormous flock passing northward. In the night following, a flock of several hundred was resting on the ice at the same place and afterward flew away northward.

On 24 May an adult male was found dead on the south coast of Faddejefski Island.

On 3 June an immense flock passed along the west coast of the Island of New Siberia, going southward.

On 6 June a flock of seven was seen at the same place, going toward the northeast.

At the same locality, 8 June, a flock of seven to nine birds, heading southward, was seen, and on 9 June a small flock going northwest, passed at the same spot.

On 11 June a dead male was found on the shore of Wosnessenskaja Bay.

In 1903, the first pair, a male and a female, was seen by Quartermaster Tolstow 30 April on Faddejefski Island. On 4 June Kolchak noted their arrival between Kotelny and Little Ljakoff Islands. They were seen by the same explorer, 5 June, on the south coast of Kotelny Island, and appeared 7 June in the vicinity of Camp Michailow.

From the notes above detailed, we see that the King Eider appears in the New Siberian archipelago (lying in the same latitudes as Western Taimyr—76° north) almost fifty days earlier, at a time when the temperature during the day remains at 10° to 15° below 0° Centigrade and at night falls considerably lower still. The journey that these birds make in the month of May is so exhausting that in both years a number of birds were found by our explorers either dead or quite spent with fatigue. What then is the explanation of this strange fact, and especially of the return of numerous flocks southward in the first days of June? In order to give a satisfactory solution to these questions it should first be noted that several explorers (Hedenström, Naval Lieutenant Anjou, and Brusneff) have established the fact that to the north of the New Siberian archipelago there are vast open areas free of ice not only in spring but also in the winter season. These open places result from the constant movement of the ice floes that takes place, as shown by the drifts of the "Jeanette" and of the "Fram," from the north of the New Siberian archipelago in the direction of the Greenland coasts. Here, near the New Siberian islands, the floes, carried by the drift, separate and leave an open area whereas in the opposite direction, on the Greenland side, they drive together and completely cover the sea. The King Eider is one of those birds that do not go but a short distance from their breeding grounds to spend the winter but content themselves with any nearby area of open sea where sufficient food may be had. Those birds that nest in the New Siberian archipelago and along the coasts of the Siberian Arctic Ocean to the east of the Lena delta, probably pass eastward in autumn and spend the winter in regions along the Siberian coast if they find open water there, and perhaps in part in Bering Sea. At the beginning of spring, in the month of May, they begin to make their way toward their customary breeding grounds and seek the open areas to the north of the New Siberian archipelago. In early June those birds that nest on the mainland return thither and for some time frequent the ponds of the tundra formed by the melting snow, until the ice breaks up in the Arctic Ocean. It is from here that they go in late June to their breeding grounds. The absence of areas of open water in the latitudes of Taimyr prevents the Eiders from wintering there or from seeking these regions in early spring. Probably the King Eiders that nest in Taimyr depart westward in autumn and spend the winter in some parts of the Kara Sea or Barents Sea. They do not reach Taimyr from thence until the last days of June, that is, just before the beginning of their nesting season, and in view of the lack of open water in the ocean to the north of this peninsula, they would have no reason either to seek these regions earlier or to return south to their nesting grounds later.

We have the following data as to the different periods in the breeding season of the King Eider from the region of the Eurasian tundra. In Spitzbergen (Sect. I) egg-

laying takes place according to Professor König (Avif. Spitzb., p. 247, 1911) from mid-June till the first of July. A female killed by Walter (Journ. f. Ornith., vol. 38, p. 239, 1890) 7 June 1899 in Whales Point Bay contained in its oviduct an egg still lacking the shell, and Birula (Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 169, 1910) took a young bird 16 August 1899 that had reached only two-thirds the adult size and was partially covered with down. On Kolguev Island (Sect. V), according to Trevor-Battye (Icebound on Kolguev, p. 428, 1895), sets are complete about the end of June or first of July; the eggs found 19 July were heavily incubated and young appeared everywhere after 21 July. In Nova Zembla (Sect. VIII) Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 311, 1908) on 5 August saw two young birds that had almost attained the size of their parents; Schaanning (*l.c.*) found the first young birds at Matochkin-shar 29 July 1903 and again, saw five young in down 13 September 1902; Gorbunow (*in litt.*) saw on 7 August 1925 very small young in down. Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 328, 1912) found in the valley of the Morda River, Yamal peninsula (Sect. X), heavily incubated eggs 7 July and young in down on 18 July. In Western Taimyr (Sect. XII) Dr. Walter (1902, *et in litt.*) found on 7 July four eggs in a nest, whose complete set consisted of but five. We must, therefore concede that this set would probably have been completed on the following day. Middendorff (*l.c.*) found a nest containing fresh eggs, 7 July 1843, and in the same region secured small young in down 5 August. Birula also took fairly large young in down on 21 August. At Sagastyr, mouth of the Lena (Sect. XIV), Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 129, 1887) found on 22 June 1884, a nest with two eggs (set incomplete), and on 2 July 1884 eggs. On the islands of the New Siberian archipelago (Sect. XVI) Dr. Bunge (*ibid.*, p. 278) on 3 July 1886, took an incomplete set of three eggs on Great Ljakoff Island and Kolchak (*in litt.*) on 18 June 1902, found a nest containing a single egg fifteen kilometers from Camp Michailow, Kotelny Island. On the same island near Nerpalach, Dr. Katin-Jartzeff (*in litt.*) secured a set of seven eggs, 3 July 1902. The same explorer notes that the Eiders appeared there with young from 12 to 18 July 1902, while Kolchak (*in litt.*) in 1903 found broods of these birds near Camp Michailow on 20 July. Finally Birula (1907) on 30 June 1902, discovered a set of six slightly incubated eggs on the Island of New Siberia. Concerning the nest of this latter set, he gives the following account.

> The nest was placed near a stream in a low, damp spot, covered with moss, at a distance of a meter from a pool of water; it was round, of about 25 cm. diameter, shallow, and lined carefully with a thick layer of rather stiff down. It contained six eggs, promiscuously arranged, that nearly filled the interior. They were still but slightly incubated. The female left the nest when I had approached to about fifteen paces distance, deluged the eggs with liquid whitewash and escaped, running and fluttering her wings.

While the females were incubating, the males stayed on the lakes near their nests and no longer frequented the sea, nor did they begin to appear there until after 8 August. The first broods were seen on the Island of New Siberia 19 and 23 July 1902.

The eggs of three sets brought back by the Russian Polar Expedition present no noteworthy differences in coloration. They show the following dimensions and weights:

1. Five eggs, slightly incubated, 16 July 1901, west coast of Taimyr Strait (Dr. Walter).— 66.2 mm. x 42.7 (440 cg.); 63 x 42 (422 cg.); 65 x 41 (417 cg.); 65.5 x 42.7 (498 cg.); 62.5 x 42 (427 cg.).

2. Four eggs (of seven), 3 July 1902, Nerpalach, Kotelny Island (Dr. Katin-Jartzeff).— 65 mm. x 44.5 (506 cg.); 63 x 43.2 (457 cg.); 64.6 x 43.6 (475 cg.); 62.8 x 43 (464 cg.).

3. Six eggs, slightly incubated, 30 June 1902, Island of New Siberia (A. Birula).— 66 mm. x 43 (507 cg.); 63 x 44 (481 cg.); 67 x 43 (505 cg.); 64 x 43.5 (499 cg.); 66.5 x 43 (524 cg.); 66.9 x 44 (485 cg.).

The males undergo their moult during the month of July but a few retain their breeding plumage till the end of the month. In 1901, on 8 August, Birula (1907) saw a male in breeding dress in Western Taimyr; and on the Island of New Siberia he saw flocks containing birds in similar condition on 10 August 1902.

We are almost without data as to the time when the King Eiders leave their breeding grounds. Bilkiewicz (App. Mem. Exp. Univ. Kasan, p. 21, 1904) alone states that these birds began to disappear from Nova Zembla in 1904 in mid-September and that about 28 September only solitary individuals were to be found. At Matochkin-shar, Schaanning (*l.c.*) saw the last ones on 27 October 1902. The Russian Polar Expedition has furnished us with no exact data on this matter; but Kolchak (*in litt.*) states that the males gathered into flocks of from ten to fifteen birds after 1 August 1903, and Dr. Katin-Jartzeff (*in litt.*) saw large flocks in the region of Kotelny Island 27–29 August and 4 September 1902.

Merganser (=Mergus) merganser merganser (Linné).—This Merganser is a representative of the fauna of the forest region, appearing rarely within the limits of the tundra but breeding at times near the boundary of the zone. Its range does not extend so far to the north as does that of the Buff-breasted Merganser, *Merganser serrator* (Linné).

In the latitudes of the Murman coast (Sect. III) it occasionally appears in spring according to Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903, in Russian) as well as in summer and has been found to breed in the eastern part of this coast. Farther to the eastward this bird has been reported from Kolguev Island (Sect. V), from the northern Ural and from the Yamal peninsula (Sect. X), whence Wardropper, naturalist of the expedition under command of Backlund, sent to our Zoölogical Museum an adult male killed 1 August 1909 on the Kara River. Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 329, 1912) also reported it from the Yamal peninsula, and it is known from Vaigach Island (Sect. VII) and the south island of Nova Zembla (Sect. VIII). Finally, in the region of the Indigirka River (Sect. XVIII) a Merganser has been seen by the natives (Zitkow and Sensinow, Journ. Sec. Zoöl. Soc. Friends Nat. Sci., Anthrop., and Ethnogr., new ser., vol. 3, no. 2, p. 19,

1915) but the species was not identified properly. The Russian Polar Expedition did not meet with this bird.

67. **Merganser (=Mergus) serrator** (Linné).

Local names: in Samoyede the Merganser bear the name *harre-gart* (Trevor-Battye, at Kolguev Island for *Merganser merganser* (Linné)) or *chalangad* (Molchanow, on Nova Zembla for *Merganser serrator* (Linné)); this name is evidently the same but transcribed differently.

As already mentioned in the article on the preceding species, the Buff-breasted Merganser as a representative of the fauna of the subalpine region ranges farther northward than the Common Merganser and for this reason breeds in greater numbers along the edge of the Eurasian tundra. It is not rare during the breeding season in the latitudes of the Murman coast (Sect. III) (see Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 122–123, 1903, in Russian), occurs on Kolguev (Sect. V) and Vaigach (Sect. VII) Islands, is very common on the south island of Nova Zembla (Sect. VIII, a), is found also but in more limited numbers, on the north island (Sect. VIII, b) and, finally, has been observed in the Yamal peninsula (Sect. X) by Zitkow (Annuaire Mus. Zool. St. Pétersbourg, vol. 17, p. 328, 1912).

The Russian Polar Expedition met with the Buff-breasted Merganser only on 7 August 1900 in Jugor Strait, in the latitudes of Vaigach Island (Sect. VII) (Dr. Walter, *in litt.*).

Mergus albellus Linné.—Specimens of this bird, evidently accidental visitors, have been recorded by Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) 29 May 1899 at Yeretiki and 14 May 1901 at Kola in Russian Lapland (Sect. III) and by Smirnow (Ornith. Jahrb., vol. 12, p. 206, 1901) at Gussinaja Zembla (=Goose Land) in the south island of Nova Zembla (Sect. VIII, a), 21 July.

PELECANIFORMES.

Phalacrocoracidae.

Phalacrocorax carbo (Linné).—The Common Cormorant is a sedentary species along the Murman coast (Sect. III). Elsewhere, it has been noted as of casual occurrence in 1907 in the Kara Sea (Sect. X) by the Duc d'Orléans (Revanche de la Banquise, 1909). It has not been reported elsewhere along the Eurasian Arctic Ocean nor was it met with during the voyage of the Russian Polar Expedition.

Phalacrocorax graculus graculus (Linné).—The Double-crested Cormorant nests in small numbers in the western part of the Murman coast (Sect. III) (see Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 124, 1903, in Russian) but becomes more abundant only in the Norwegian portions of the arctic coast.

Phalacrocorax pelagicus (Pallas).—*Local name:* in Chukche, *ijurgui* (Palmén). I consider that the Cormorants seen by Dr. Bunge (Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 601, 1883) in the region of the Lena delta (Sect. XIV) must have been of this species. In the extreme east of the Siberian arctic coast this bird has been found on the northern shores of the Chukche peninsula (Sect. XXI), first in the vicinity of the "Vega's" winter-quarters (Palmén, Sibir. Ishk. Fogelf., p. 412, 1887), next by the "Corwin" (Nelson, Cruise of the Corwin, p. 103, 1883, under *Phalacrocorax violaceus* Gmelin and *Phalacrocorax bicristatus* Pallas) in the latitudes of Cape Serdze Kamen and in small numbers in the vicinity of Wrangel and Herald Islands (Sect. XX). In this part of the arctic coast, the bird should not be rare since the Russian Hydrographic Expedition to the Arctic Ocean brought back from the mainland and from Wrangel Island at least eight specimens of this Cormorant that are now in our

Zoölogical Museum of the Academy of Sciences. Koren's expedition (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 31, 1914) likewise found it in various places on the north coast of the Chukche peninsula, notably about a dozen birds at Cape Kibera and in considerable numbers in the breeding colonies at Cape Irkaipij and Koljuchin Island. According to Dr. Savich (Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 37, 1927) this Cormorant was extremely abundant in 1915 in the vicinity of Cape Severny (Irkaipij).

SULIDAE.

Sula (=**Moris**) **bassana** (Linné).—The Gannet occasionally appears as an accidental visitor to the latitudes of the Murman coast (Sect. III) (see Goebel, Mém. Soc. St. Pétersbourg, vol. 33, p. 122–125, 1903, in Russian) but obviously it cannot be included among the birds of the Eurasian tundra.

PROCELLARIIFORMES.

PROCELLARIIDAE.

68. **Fulmarus glacialis glacialis** (Linné).

Fulmarus glacialis (Linné). BIRULA, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 8, 41, 1907.

The Fulmar breeds only in the archipelagoes of the western part of the Eurasian Arctic Ocean, frequenting the coasts of the mainland only to winter, but not nesting there anywhere. However, it occurs in small numbers in the open sea at some distance from the mainland in all seasons of the year, which makes us suppose that the immature birds, probably those of the preceding year, are not as yet breeding.

In Spitzbergen (Sect. I) the Fulmar nests in many places in countless numbers, and on Bear Island (Sect. II) it is also very abundant in the breeding season. Again it has been found to breed not only in the Franz Josef archipelago (Sect. IX) itself, but was also seen by Nansen (Collett and Nansen, Norw. North Polar Exp., p. 36, 1899) beyond that archipelago to Cape Fischer in latitude 81° north. Although its breeding in Nova Zembla (Sect. VIII) could not be doubted, it remained for the geologist Russanow (Mat. for the Investigation of Nova Zembla, pt. 2, p. 24, 1911, in Russian) to find, on the northwest coast of the north island, on William Island, between Nordenskjöld and Archangel Bays, a large colony of Fulmars. According to Gorbunow (*in litt.*) a second colony is probably situated at the extremity of the northern island, on Cape Gelanija. In the Kara Sea, on Lonely Island (Ujedinenija) (Sect. XII) where Johansen (Mohn, Peterm. Geogr. Mitth., 1879, p. 57–59) found a colony, its breeding range reaches its eastern limit. It does not nest either on Preobrashenije Island (Sect. XIII) or on the "gull rocks" of the New Siberian archipelago (west coasts of Bielkovski and Kotelny Islands) (Birula, 1907) and in the far east is replaced by an eastern race, *Fulmarus glacialis rodgersi* Cassin. Along the Murman coast (Sect. III), in the Kanin peninsula (Sect. IV), on Kolguev Island (Sect. V) and in the Kara Sea (Sect. X) it has been found regularly at times other than the breeding season and irregularly at all seasons.

The Russian Polar Expedition only once met with the Fulmar, namely, between 6 and 11 September 1901 in the Nordenskjöld Sea during the passage of the ship from Taimyr to Bennett Island (Birula, 1907).

The data as to the arrival of the Fulmar on its breeding grounds may be presented in the following table:

Spring Arrival of the Fulmar.

Spitzbergen (Sect. I)	Bear Island (Sect. II)	Franz Josef Archipelago (Sect. IX)
4 Mch. 1873, Mossel Bay [1]	mid-February 1825 [6]	24 Apl. 1882, Cape Flora (*teste* Dr. Neale) [7]
20 Feb. 1889, Amsterdam Id. (*teste* Pike) [2]		20 Mch. 1895, Cape Flora [8]
16 Jan. 1899, (uncertain) (*teste* Bunge) [3]		13 Mch. 1896, Cape Flora [8]
19 Jan. 1899, (seen in dim light) [3] between 20-28 Feb. 1899 (same conditions) [3]		5 Apl. 1896, Nansen's winter-quarters [9]
6 Mch. (observation certain) [3]		7 Apl. 1897, Cape Flora (*teste* Dr. Bruce) [7]
13 Feb. 1900 (single birds) [3]		
16 Feb. 1900 do. [3]		
31 Mch. 1900 (numerous) [3]		
5 Feb. (*teste* Sendsen) [4]		
20 Feb. 1912, Advent Bay, several hundred [5]		
21–24 Feb. 1912, Green Harbor (*teste* Dr. G. Rempp) [5]		

[1] Nordenskjöld, Bih. Kongl. Svenska Vet. Akad. Handl., vol. 2, no. 18, p. 59, 1875.
[2] Chapman, Wild Norway, p. 347, 1897.
[3] Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 307, 1902.
[4] Münsterhjelm, Oefv. Finska Vet.-Soc. Förh., vol. 53, p. 20, 1910.
[5] Mathey-Dupraz, Bull. Soc. Nat. Neuchâtel, vol. 39, p. 109, 1913.
[6] Keilhau, Reise i. Ost.- og West-Finm., Beer-Eil. og Spitzb., p. 130, 1831.
[7] Clarke, Ibis, 1898, p. 274.
[8] Jackson, A Thousand Days in the Arctic, p. 411, 1899.
[9] Collett and Nansen, Norweg. North Polar Exp., p. 36, 1899.

If we allow an incubation period of from six to seven weeks, egg-laying would take place in Spitzbergen (Sect. I) according to Professor König (Avif. Spitzb., p. 206, 1911) at the beginning of May, which does not at all accord with the statements of the following naturalists who have visited Spitzbergen: Malmgren (Journ. f. Ornith., vol. 13, p. 208, 1865) on 18 and 19 June found many slightly incubated eggs and in some nests there were already young birds, and Römer and Schaudinn (Fauna Arct., p. 81, 1900) found fresh eggs 14 July, that Professor König (*l.c.*) took for second sets in cases where the first ones were destroyed. Probably egg-laying really takes place slightly later than the above calculation, about the end of May or in the first days of June. On Bear Island (Sect. II) according to Kolthoff (Kongl. Vet. Akad. Handl., vol. 36, p. 9, 1903) eggs were fresh or but slightly incubated by 13 June; Professor König (*l.c.*, p. 206) states that in mid-June 1907 the eggs were all fresh, while at the beginning of July 1908 they were well advanced in incubation. Swenander (Bih. Kongl. Svenska Vet. Akad. Handl., vol. 26, no. 3, p. 27, 1900) found eggs heavily incubated at the end of June; in the first days of July he found the first young birds of different sizes but at the same time heavily incubated eggs that

belonged to second sets. The same observer states that by 19 August the young birds were not yet on the wing. This last observation agrees with the results of Zedlitz (Journ. f. Ornith., vol. 59, p. 317, 1911) according to which the young birds, 12 August, were not to be seen either on the wing or on the sea. In the Franz Josef archipelago (Sect. IX) according to Clarke (*l.c.*) eggs were found 5 May.

We have at hand the following data on the time of the Fulmar's departure from its breeding places. In Spitzbergen (Sect. I) Dr. Bunge (Bianchi, *l.c.*, p. 329) found them still present in abundance 17 September 1899 but by the 25th of the month he noted only single birds; Fulmars left Nova Zembla (Sect. VIII) according to Bilkiewicz (App. Mem. Exped. Univ. Kasan, p. 16, 1904) about 23 September while in the Franz Josef archipelago (Sect. IX) they disappeared 28 October 1881 (*teste* Dr. Neale,—Clarke, *l.c.*, p. 275), about 10 September 1894, 18 September 1895, and 23 September 1896 (Jackson, *l.c.*); in this last year, according to Clarke (*l.c.*) Wilton saw them up to 6 October.

It only remains to add that the Fulmar was found by the "Fram" (Collett and Nansen, *l.c.*, p. 50) as far as 85°5′ north latitude, the most northerly point attained by any species of bird.

Fulmarus glacialis rodgersi (Cassin).—The eastern form of Fulmar was observed by Nelson (Birds of Alaska, p. 62, 1887) in the latitudes of Wrangel (Sect. XX, a) and Herald (Sect. XX, b) Islands and along the north coast of the Chuckche peninsula (Sect. XXI); and again by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 7, 1914) at about 20 leagues from Cape Deshneff.

COLYMBIFORMES.

Urinatoridae (=Gaviidae).

69. **Urinator** (=**Gavia**) **stellatus** (Pontoppidan).

Colymbus septentrionalis (Linné). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 386, 1901; *ibid.*, vol. 16, no. 5, p. 233, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 5–7, 13–14, 18, 36, 1907.

List of Specimens from the Russian Polar Expedition.

Skins: adult, 15 June 1901, young in down, 20 August 1901, west shore Taimyr Strait (Dr. Walter); young in down, 10 September 1900, Middendorff Bay, Western Taimyr (Dr. Walter); adult male, 3 July 1902, Nerpalach Bay, Kotelny Island, New Siberian archipelago (Dr. Katin-Jartzeff); adult, 8 July 1901, Camp Michailow, Kotelny Island (Dr. Katin-Jartzeff); adult, 15 July 1902, Charaulach River, Lena delta (M. Brusneff).

Eggs: two, 15 July 1901, west shore of Taimyr Strait (Dr. Walter); two, 11 July 1902, mouth of Charaulach River, Lena delta (M. Brusneff); two, 3 July 1902, one, 6 July 1902, two, 7 July 1902, Nerpalach Bay, Kotelny Island, New Siberian archipelago (Dr. Katin-Jartzeff); two, 15 July 1903, 20 kilometers north of Camp Yeliseyeff, New Siberian archipelago (P. Olenin); two, 13 July 1902, Island of New Siberia (A. Birula); one, 1 August 1903, Wosnessenija River, Island of New Siberia (M. Brusneff); one, 4 August 1903, Faddejefski Island, New Siberian archipelago (P. Tolstow).

Local names: in Russian, latitudes of the Yana, *gagára* or *malaja gagára* (Birula); in Samoyede, on Kolguev Island, *paduoreh, pei-o-reh* (Trevor-Battye); in Taimyr, *njúa-nâa* (Middendorff); in Yakut, *byttá,* or rarely *kuchugúi kôhas;* in Tunguse, *ukán* or *ökán* (Birula); in Chukche, *jouku* (Palmén).

The Red-throated Diver inhabits the entire extent of the Eurasian tundra region, and the only localities from which it has not been certainly recorded are the De Long Islands (Sect. XVII), Wrangel and Herald Islands (Sect. XX); but Nelson (Cruise of the Corwin, p. 115, 1883) expressed his opinion that it occurs in those regions also.

The Russian Polar Expedition met with this Diver first on 13 August 1900 in Dickson Bay (Sect. XI); next, 10 September 1900 in Middendorff Bay (Sect. XII) (Walter, 1901, 1902, *et in litt.;* Birula, 1907). At the winter-quarters of the "Sarja" it was not found in the autumn of 1900, probably because it had already left these latitudes. In 1901, it was an abundant breeding bird. In the vicinity of the Lena delta, Brusneff (*in litt.*) in 1902 found it in considerable numbers and succeeded in securing a set of eggs.

In the New Siberian archipelago, where Dr. Bunge (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, pp. 277, 283, 1887) had previously found the species on Great Ljakoff Island, it was everywhere found in 1902 and 1903, breeding in considerable numbers, notably on Kotelny Island, in the neighborhood of Nerpalach Bay, by Dr. Katin-Jartzeff (*in litt.*); near Camp Yeliseyeff by Olenin (*coll. exped.*) and in smaller numbers at Camp Michailow by Kolchak (*in litt.*). Again, it was noted in abundance on the Island of New Siberia by Birula (1907) in 1902 and by Brusneff (*coll. exped.*) in 1903, as well as during the summer of the same year by Tolstow (*in litt.*) on Faddejefski Island.

We have only the following data on the arrival of the Red-throated Diver in the Eurasian tundra region. In Spitzbergen (Sect. I) Walter (Journ. f. Ornith., vol. 38, p. 243, 1890) noted the first birds 31 May 1889; on the Murman coast (Sect. III) Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) saw them at Yeretiki 24 April 1882, 20 April 1884, 17 April 1896, 11 May 1899 and 16 May 1900; and at Alexandrovsk 14 May 1901. In Nova Zembla (Sect. VIII) Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 95) recorded their appearance 20 June 1903. In Western Taimyr (Sect. XII) according to Dr. Walter (*in litt.*), the first birds were not seen until 23 June 1901 while from Dr. Bunge's observations (Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 125, 1887) this species appeared at the mouth of the Lena (Sect. XIV) 10 June 1884 and on Great Ljakoff Island (*ibid.*, p. 277) 21 June 1886.

The length of the incubation period in this species was stated by Römer and Schaudinn (Fauna Arct., p. 30, 1900) to be from twenty-four to twenty-eight days, or an average of twenty-six days. On the basis of this latter figure, the data as to time of egg-laying and hatching of the young in the different sections of the tundra region may be presented as follows.

Breeding of Red-throated Diver.

Incubation period 24–28 days, average 26 days		Spitzbergen Sect. I	Bear Id. Sect. II	Murman Coast Sect. III	Vaigach Id. Sect. VII	Nova Zembla Sect. VIII	Western Taimyr Sect. XII	New Siberian Archipelago Sect. XVI	Mouth of the Kolyma Sect. XIX	North Coast of the Chukche Peninsula Sect. XXI
Eggs laid	Early dates			Between *9–20 June*[6] (Pasvig R.)	19 June [7]					
	Normal dates	23 June [1] *26 June 1907 and 1908*[2] *27 June*[3] *1 July*[3] *7 July*[3] *Between 1 and 7 July 1907, 1908*[3] *3 July 1910*[4] (5 sets, of which 4 fresh, 1 slightly incubated)	1 July[5]	*24 June*[6] (Western part of Murman Coast)		*23 June*[1] *24 June*[1]	*15 July 1901*[8] 17 July 1901[8]	*2 July 1903*[10] (Faddejefski Id.) *3 July 1902*[11] (Kotelny Id.)	*26 June 1912*[12] (Delta)	
	Late dates		6–7 July[6]	*1 Aug.*[6] (West part Murman Coast)		12 July[6]			*15 July 1912*[12] (7 days inc.) 8 July 1912[12]	29 July 1912[12] (Cape Bolshoi Baranovski)
Young hatched	Early dates			Between 5–16 July[6] (Pasvig R.)	*15 July*[7] (Young in down)					
	Normal dates	*19 July* (first young)[1] 22 July 1907 and 1908[2] 23 and 27 July[3] Between 27 July and 3 Aug. 1907 and 1908[3] 29 July 1910[4]	*4 Aug.*[5] (A brood almost 8 days old) 27 July[6]	20 July[6] (West part Murman Coast)		19 July[1] 20 July[1]	10 Aug. 1901[8] *12 Aug. 1901*[8]	28 July 1903[10] (Faddejefski Id.) 29 July 1902[11] (Kotelny Id.)	22 July 1912[12] (Delta)	
	Late dates		*4 Aug.*[5] 1–2 Aug.[5] (2 broods 2–3 days old)	26 Aug.[6] (West part Murman Coast)		*1 Aug.*[6] 7 Aug. (eggs much incubated—20 days)			3 Aug. 1912[12] (Delta)	24 Aug. 1912[12] *1 Sept. 1912*[12] (young 8 days old) (Cape Bolshoi Baranovski)

[1] von Heuglin, Reise Nordpolm., vol. 3, p. 156, 1874.
[2] König, Avif. Spitzb., p. 268, 1911.
[3] Kolthoff, Kongl. Svensk. Vet. Akad. Handl., vol. 36, no. 9, p. 78, 1903.
[4] Münsterhjelm, Oefv. Finsk. Vet.-Soc. Förh., vol. 53, p. 20, 1910.
[5] Swenander, Bih. Kongl. Svensk. Vet.-Akad. Handl., vol 26, pt. 4, no. 3, p. 32, 1900.
[6] Goebel, Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 130, 1903 (in Russian).
[7] Pearson, Ibis, Ser. 7, vol. 4, p. 204, 1898.
[8] Molchanow, Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 308, 1908.
[9] Dr. Walter, *in litt.*
[10] S. Tolstow, *in litt.*
[11] Dr. Katin-Jartzeff, *in litt.*
[12] Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 7, 1914.

From this table we may draw the following conclusions: In Spitzbergen (Sect. I) and on Bear Island (Sect. II) egg-laying normally takes place between 10 and 20 June but occasionally also in the last days of that month or the first days of July, for Römer and Schaudinn (Fauna Arct., p. 80, 1900) found a very young bird 7 August 1898 and Birula (Annuaire Mus. Zool. St. Pétersbourg, vol. 15, p. 170, 1910) two young in down 17 August 1900 at Stor Fjord. In the western parts of the Murman coast (Sect. III) the Red-throated Divers seem to nest earlier: thus in the region of Pasvig-elf (Goebel, *l.c.*) fresh sets were found between 9 and 20 June; in the eastern parts of this coast, fresh sets were found between 24 June and 1 August. This latter date must, I think, be a typographical error for July 1, a supposition that gains probability in view of the fact that Goebel found young birds there 11 July. The dates on the normal time of egg-laying in Nova Zembla (Sect. VIII) correspond to dates of first sets in Spitzbergen, while those for the New Siberian archipelago (Sect. XVI) correspond to the dates of the latest sets in Spitzbergen. But occasionally the sets in Nova Zembla must be laid much later for von Heuglin (*l.c.*) found young still of very small size in the end of August at Matochkin-shar, and this was confirmed by Schaanning (*l.c.*) who in the case of three nests at that locality did not find the first eggs until 5 July, 6 July and 10 July 1903, respectively. Gorbunow (*in litt.*) tells me that a young in down, killed at Nova Zembla, 22 August 1925, was half grown. According to Dr. Walter's observations (*in litt.*) the time of egg-laying in Western Taimyr (Sect. XII) is much later in comparison with the dates just cited—not until mid-July—and must occasionally be even later since he found on 10 September 1900, young birds that were about half the size of their parents.

In the parts of the Eurasian tundra explored by the Russian Polar Expedition, the Red-throated Diver breeds along the miry shores of lakes and large bodies of water where at the water's edge they make their very compact nests of moss, with a height of about 25 cm. and a carefully prepared foundation (see Pl. 28, figs. 1, 2). Birula (1907) made the very interesting observation that the Divers that stay with their newly hatched young on the neighboring lakes go back to the nests with their young, that is, they continue to use them for some while after the young ones hatch.

The Russian Polar Expedition brought back a considerable series of sets of this bird, among which the eggs do not differ except in the amount of black spots on the brown ground. Dimensions and weights follow.

1. Two eggs, 15 July 1901, western part of Taimyr Strait (Dr. Walter).—65 mm. x 41 (486 cg.); 66.6 x 42.5 (500 cg.).

2. Two eggs, 11 July 1902, Charaulach Mts., Lena delta (M. Brusneff).—71.7 mm. x 44.8 (594 cg.); 71.1 x 44 (560 cg.).

3. Two eggs, 3 July 1902, Nerpalach Bay, Kotelny Island, New Siberian archipelago (*Dr. Katin-Jartzeff*).—68 mm. x 43.6 (525 cg.); 68.6 x 45 (534 cg.).

4. One egg, 6 July 1902, Nerpalach Bay, Kotelny Island (*Dr. Katin-Jartzeff*).—72 mm. x 44 (685 cg.).

5. Two eggs, 7 July 1902, Nerpalach Bay, Kotelny Island (*Dr. Katin-Jartzeff*).—71.5 mm. x 44.9 (668 cg.); 71 x 44.1 (—).

6. Two eggs, 15 July 1903, twenty kilometers north of Camp Yeliseyeff, Kotelny Island (*Dr. Katin-Jartzeff*).—70.7 mm. x 45 (—); 68.6 x 46.1 (—).

7. Two eggs, 13 July 1902, Island of New Siberia (*A. Birula*).—69.5 mm. x 45 (612 cg.); 69 x 43.8 (601 cg.).

8. One egg, 1 August 1903, Wosnesenija River, Island of New Siberia (*M. Brusneff*).—75.5 mm. x 42.1 (624 cg.).

9. One egg, 4 July 1903, Faddejefski Island (*S. Tolstow*).—77.7 mm. x 43.2 (700 cg.).

We have only the following notes as to the time of this Diver's departure from its breeding grounds. In Spitzbergen (Sect. I), Cocks (Zoologist, 1883, p. 486) saw the last birds in Sassen Bay 13 September 1882 and Münsterhjelm noted the three last individuals in Spitzbergen on 15 September 1910. They seem to leave the latitudes of Nova Zembla (Sect. VIII) a little earlier for Bilkiewicz (App. Mem. Exped. Univ. Kasan, p. 13, 1904) states that he saw none after late August. The last ones were seen on Great Ljakoff Island, according to Dr. Bunge (*l.c.*, p. 283) on 9 September 1886.

70. Urinator (=Gavia) arcticus arcticus (Linné).

Colymbus arcticus Linné. Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 386, 1901. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 2, 36, 1907. Toll, Die russ. Polarf. d. "Sarja," pp. 48, 68, 83, 1909.

List of Specimens from the Russian Polar Expedition.

Skin: adult male, 15 July 1902, mouth of the Charaulach River, Lena delta (M. Brusneff).
Egg: one, 15 July 1902, same place and collector.

Local names: in Samoyede, Kolguev Island, *paduoreh deinunya* (Trevor-Battye); in the Taimyr peninsula, *oku-djarre* (Middendorff); in Yakut, region of the Yana, *tallán* or *orto-kohas* (Birula).

The Black-throated Diver does not reach such high latitudes as the Red-throated species. It has several times been found in Spitzbergen (Sect. I) and Professor König's doubts as to its occurrence there (Avif. Spitzb., p. 269, 1911) are unwarranted for the Oxford Expedition (Jourdain, Ibis, 1922, p. 168) on 13 July 1921 was fortunate in finding a bird of this species on Richard Lagoon, northwest of Prince Charles Foreland, that was identified with the help of powerful glasses by S. Gordon, D. Brown, H. Paget-Wilkes and F. Jourdain. No Black-throated Diver has been found either on Bear Island (Sect. II), in the Franz Josef archipelago (Sect. IX), in the New Siberian archipelago

(Sect. XIII), in the De Long archipelago (Sect. XVII), or on Wrangel or Herald Islands (Sect. XX). Along the northern coast of the Eurasian continent (Sects. III, IV, VI, X, XI, XII, XIV, XV) as well as on the adjacent islands—Kolguev (Sect. V), Vaigach (Sect. VII), and the two islands of Nova Zembla (Sect. VIII, a, b)—it breeds anywhere but in smaller numbers than *Urinator stellatus* (Pontoppidan). As to the latitudes of the Yana delta (Sect. XV) I doubt not that one of the forms of *Urinator arcticus* (Linné) breeds there, but it is perhaps the small American form known as *Urinator arcticus pacificus* (Lawrence) that even there replaces the typical form.

The specimen of this Diver brought back by the Russian Polar Expedition, taken on its nest by Brusneff at the mouth of the Charaulach River, Lena system, undoubtedly belongs to the western form as previously shown by the late Bianchi (Fauna of Russia, vol. 1, p. 97, 1913, in Russian).

In 1900 the Russian Polar Expedition met with this Diver 10 August in the Kara Sea (Toll, 1909); 13 August on Kuzkin Island opposite Dickson Bay (Sect. XI) (Birula 1907); 25 August in Minin Bay (Toll, 1909) and on 27 August and 5 September in Middendorff Bay, Western Taimyr (Sect. XII) (Birula, 1907; Toll, 1909). In 1901 the species was not seen in the vicinity of the "Sarja's" first winter-quarters, which indicates that although it probably frequents the coasts of the Arctic Ocean in autumn it breeds in more southern latitudes. In the Lena delta (Sect. XIV) Brusneff in 1902 found this Diver present and on 15 July discovered a nest containing one egg. Finally Birula (1907) tells us that this bird is well known to the natives of the Yana region (Sect. XV) and that they distinguish perfectly between the two species; but we are not in a position to decide whether the European form is the one found here or whether it is replaced by the Pacific race.

The arrival of the Black-throated Diver was noted by Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) at Yeretiki on the Murman coast (Sect. III) 16 May 1882, 7 May 1884, 21 May 1896, 16 May 1899 and 16 May 1900; and at Alexandrovsk 10 May 1901. In Taimyr, Middendorff (Sibir. Reise, vol. 2, pt. 2, p. 239, 1853) recorded its arrival 18 June. Fresh eggs of this species were found by Goebel (Mém. Soc. Nat. St. Pétersbourg, vol. 33, p. 128–129, 1903, in Russian) on the Murman coast (Sect. III) at Pasvig-elf, between 6 and 15 June and in the western part of that coast on 12 July (evidently a late set). Middendorff (1853) states that fresh eggs were found in Western Taimyr (Sect. XII) 8 July; and those collected by Brusneff 15 July 1902 at the mouth of the Charaulach River, Lena river-system (Sect. XIV), were incubated. This nest was placed on an islet in the middle of a lake in a hollow. The single egg preserved measures: 84.6 mm. x 48. On 10 August 1925 Gorbunow (*in litt.*) succeeded in killing at the Belushja (Dauphin) Bay of the south island of Nova Zembla a very small bird in down, evidently newly hatched.

Urinator (=Gavia) arcticus pacificus (Lawrence).—The eastern form of the Black-throated Diver, smaller in size, replaces the western race in the Far East of the Siberian tundra but seems to frequent only the northern coasts of eastern Siberia, for specimens coming from the interior of that country belong, as we shall see, to the typical race. As I have previously remarked in the article on the latter, it is an open question whether the mouth of the Yana (Sect. XV) is inhabited by the western or the eastern subspecies. Buturlin (Journ. f. Ornith., vol. 56, p. 289, 1908) has recorded *Urinator arcticus pacificus* from the mouth of the Indigirka (Sect. XVIII) as well as from a littoral zone 15 to 20 kilometers wide in the region of the mouth of the Kolyma (Sect. XIX) (*idem*, Venery and Hunting, 1906, no. 12, p. 13, in Russian). This determination seems to be quite correct, for Bianchi, who has carefully studied the Divers, identified (*in litt.*) the specimen brought back from the mouth of the Kolyma by the Hydrographic Expedition to the Arctic Ocean, as *Urinator arcticus pacificus* (Lawrence), while he referred the specimen collected by Czerski in the Kolyma's river-system to the typical form (Fauna of Russia, vol. 1, p. 97, 1913, in Russian). I am sure the specimens listed by Koren (Thayer and Bangs, Proc. New England Zoöl. Club, vol. 5, p. 6, 1914) as *Gavia arctica* (Linné) and observed near Cape Bolschoi Baranovski and in Chaun Bay belong likewise to the eastern form. The rather numerous specimens secured by the "Vega" Expedition (Palmén, Sibir. Ishk. Fogelf., p. 406, 1887) in the latitudes of the vessel's winter-quarters on the north coast of the Chukche peninsula (Sect. XXI) belong to the Pacific form.

Urinator (=Gavia) immer (Brünnich).—The Great Northern Diver occurs regularly at times other than the breeding season in the North Sea and on the Norwegian coasts of the Atlantic whence it may readily make its way toward Spitzbergen (Sect. I) and Bear Island (Sect. II) on the one hand and to the western parts of the Murman coast (Sect. III) on the other. But at the same time I do not doubt in the least that some of the notes on this species from the regions mentioned really relate to the Eurasian species, the White-billed Diver, *Urinator adamsi* (Gray), which winters with some regularity in the same latitudes as the Nearctic species. In Spitzbergen, *Urinator immer* (Brünnich) has been taken by Dr. Bruce (Geogr. Journ., vol. 32, p. 147, 1908) in Prince Charles Land; a second specimen was found, according to Mathey-Dupraz (Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 108, 1913), 5 July 1905 by the Duc d'Orleans at Cape Starachin at the entrance to Ice Fjord; and the same writer (*ibid.*, vol. 38, p. 50, 1911) noted several individuals 24 July 1910, in Balena Bay and at the mouth of Lilliehook Bay. Lastly, between 16 and 20 August 1923, the members of the expedition from Merton College, Oxford, saw on Salmon Lakes, Dirkses Bay, east shore of Wijde Bay, three birds of this species, probably a male, a female and a young bird of the previous year (Langstaff, Ibis, 1924, p. 484) and two birds were found at the same place by Montague (Ibis, 1926, p. 144). In addition to these instances, the literature contains a number of notes as to the occurrence of this species in Spitzbergen, but the identification of the birds seen must be regarded as questionable. In the latitudes of Bear Island (Sect. II), Nathorst (Bih. Kongl. Svenska Vet. Akad. Handl., vol. 9, no. 2, p. 570, 1884) saw two birds 10 September 1882, which he later, after an examination of specimens in the Tromsö Museum, regarded as of this species. On the Murman coast, Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901) noted some Divers 14 September 1884, that he distinguished from *Urinator adamsi* (Gray) and again at Alexandrovsk, Kola Bay, 18 August 1900; while Smirnow (Goebel and Smirnow, Ornith. Jahrb., vol. 13, p. 47, 1902) observed two birds 3 January 1901 between Kola Bay and Rybachi peninsula. Finally I must mention a specimen of this Diver killed by Fedosow (The Ukraina Hunter and Fisherman, 1926, no. 6, p. 43, in Russian) in 1921 at the mouth of the White Sea at Cape Gorodetzki. Records of the occurrence of the Great Northern Diver to the eastward of the White Sea (Gillett, Feilden, von Heuglin, Middendorff) undoubtedly relate to *Urinator adamsi* (Gray), so that I will confine myself to citing the following doubtful notes on *Urinator immer:* Goebel (St. Pétersb. Herold, no. 43, 1879) claims to have killed a bird of this species in Karmakuly Bay (Nova Zembla), but I do not doubt that it was *U. adamsi* (Gray), for at that time Goebel evidently was still in doubt of the existence of these two separate species. Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 308, 1908) on the other hand, who was well

acquainted with the differences between the two, believed he had seen a Great Northern Diver 25 July on a lake in the vicinity of Belushja Bay.

71. Urinator (=Gavia) adamsi (Gray).

Colymbus glacialis, Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 15, no. 4, p. 386, 1901. Toll, Die russ. Polarf. d. "Sarja," p. 67, 1909.

Colymbus adamsi (Gray). Walter, Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 234, 1902; Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 154, 1902. Birula, Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2, pp. 7, 36, 39, 1907.

List of Specimens from the Russian Polar Expedition.

Skin: adult male, 2 July 1901, west shore of Taimyr Strait (Dr. Walter).

Local names: in Russian, latitudes of the Yana, *gagara, bolschaja gagara;* in Yakut, *ulachan kohas*, or more often *sylgyly-kystir-kohas* (meaning Diver that neighs like a horse); in Tunguse, *kiemelga* (Birula); in Chuckche, *uránketsjouku* (Palmén).

The White-billed Diver probably occurs occasionally, as I have already stated in the account of the preceding species, in the latitudes of Spitzbergen (Sect. I). According to a recent note of Count Zedlitz, zoölogist of the Zeppelin Expedition (Journ. f. Ornith., vol. 59, p. 301, 1911) a Black-necked Diver probably of this species was noted 5 August 1910 near Amsterdam Island. In the latitudes of the Murman coast (Sect. III) it is of regular occurrence in the open sea and in addition to the records enumerated in my work on the fauna of Russian Lapland (Pleske, Crit. Rev. of the Mamm. and Birds of the Kola Penin., p. 500, of the Russian edition, 1887), a certain number of which must, however, be referred to *Urinator immer* (Brünnich), it was noted on 30 October 1899 in Yeretiki Bay by Goebel (Ornith. Jahrb., vol. 12, p. 215, 1901); on 16 January 1900, two birds and 20 December 1900 three more were recorded by Smirnow (Ornith. Jahrb., vol. 13, p. 47, 1902) between Kola Bay and Rybachi peninsula. According to Fedjushin (Mem. of the White-Russian Univ., 1925, nos. 8–10, p. 36, in Russian) the White-billed Diver is a rare visitor to the Kola Fjord in summer. The author of this communication has observed himself a single specimen in a little inlet of Saida Bay. According to the communication of Dr. Walch (Mess. Ornith., 1926, no. 3, p. 195) this species is common in the middle part of the Kola Fjord during the time of migration. To the east of the White Sea, from the Kanin peninsula (Sect. IV) to the north coast of the Chuckche peninsula (Sect. XXI) it appears to breed everywhere along the edge of the forest region but during the nesting season does not occur on the tundra region, except in the open areas of the Arctic Ocean, chiefly at the mouths of rivers and streams. It has not been found in some of the archipelagoes of the Arctic Ocean such as the Franz Josef archipelago (Sect. IX), the New Siberian (Sect. XVI) and the De Long (Sect. XVII) archipelagoes and on Wrangel and Herald Islands (Sect. XX), while it breeds on Kolguev (Sect. V) and

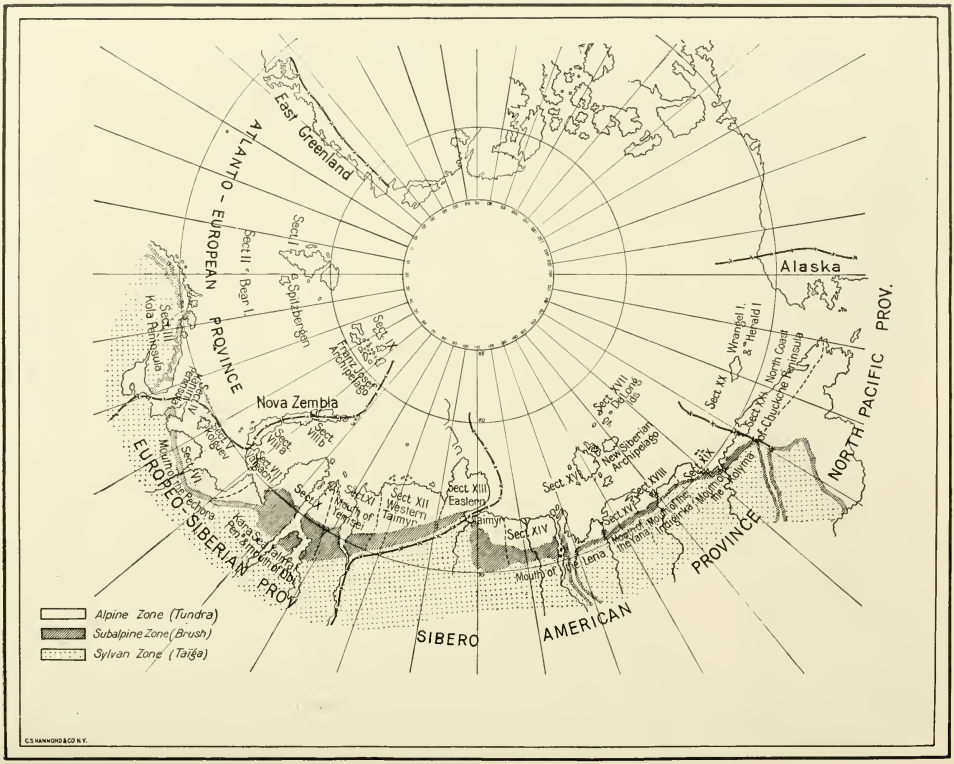
Vaigach (Sect. VII) Islands, and in rather considerable numbers on the two islands of Nova Zembla (Sect. VIII, a and b). For Nova Zembla I have the following records, either new or published after the appearance of Schalow's list: Nossilow brought back from his journey three specimens, male, female and young, which are now in our Zoölogical Museum; Buturlin (Our Hunting, 1908, no. 8, p. 54, in Russian) killed a specimen, and Molchanow (Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 308, 1908) saw another killed by a fisherman. In addition our Zoölogical Museum has received from Madame Skribowa two specimens, of which one adult was killed 29 August 1912 on the Nechvatowa River. Again, Smirnow (Nature and Hunting, 1902, no. 10, p. 2, in Russian) found this bird in Kussow Land and probably the specimen killed by Goebel (St. Pétersb. Herold, 1879, no. 43) in 1879, in Malijy Karmakuly Bay and identified as *Colymbus glacialis* was in reality a White-billed Diver. Schaanning (Bergens Mus. Aarb., 1907, no. 8, p. 94) saw one in the Matochkin-shar region in July 1903. Finally Gorbunow (*in litt.*) saw one specimen 13 September 1923 in Puchowaja Bay and another 2 October on Lake Swjatoi, near Malijy Karmakuly. For the mainland, data are lacking for the Bolschesemelskaja tundra (Sect. VI), Eastern Taimyr (Sect. XIII) and the Lena delta (Sect. XIV) but I have not the slightest doubt that it breeds in the latitudes of these sections also, especially since Miss Haviland (Ibis, 1915, p. 398) was informed by the natives at the mouth of the Yenisei that this Diver only appeared at Golchiha in the spring but nested at a distance of several hundred kilometers to the east of the Yenisei. It must be said that the old records of von Heuglin (Reis. Nordpolm., vol. 3, p. 159, 1874) for *Colymbus glacialis* from Jugor Strait (Sect. X) and of Gillett (Ibis, 1870, p. 308) for the same species from Kara Strait refer to the present species. At the mouth of the Ob it was several times noted by Prince A. Schirinski-Schichmatow (Zitkow and Buturlin, In the North of Russia, p. 170, 1901).

The Russian Polar Expedition in 1900 met with the White-billed Loon in Minin Bay (Walter, 1901; Toll, 1909, under *Colymbus glacialis*). In 1901 (Walter, 1902; Birula, 1907) these birds were present in the neighborhood of the "Sarja's" winter-quarters on the open areas of the Arctic Ocean at the mouths of rivers, where on 2 July a magnificent adult male was killed. Between 5 and 9 August, during the journey to the Kolomeitzeff River, Walter and Birula (Birula, 1907) found a large number of these Divers in Walter Bay, in flocks of from seven to ten birds, some at the mouth of this river, others in the river itself. In 1902 and 1903, this Diver was not seen by the members of the Expedition but Birula (1907) was informed by the natives of the Yana region, that it breeds but very rarely in the tundra and that its regular breeding grounds are on the lakes at the edge of the forest region, for example in the Omoloi system.

COLYMBIDAE (=PODICIPIDAE).

Pedetaithya (=Podiceps) griseigena griseigena (Boddaert). In the course of the first German North Polar Expedition, the pilot Sengstacke in 1868 secured a specimen of the Gray-cheeked Grebe, as a casual visitor, in Spitzbergen (Sect. I) and gave it to Dr. Finsch (König, Avif. Spitzb., p. 267, 1911).

Pedetaithya (=Podiceps) griseigena holboelli (Reinhardt).—The eastern form of the Gray-cheeked Grebe is recorded by Buturlin (Journ. f. Ornith., vol. 56, p. 289, 1908) from the region of the mouth of the Kolyma (Sect. XIX). The collection of Dr. Savich (Artobolewski, Mem. Kiev Soc. Nat., vol. 27, p. 37, 1927) contains a specimen of this Grebe in perfect spring plumage. Unfortunately it wants a label, so that we cannot tell if it was secured at the mouth of the Kolyma or on the north coast of the Chuckche peninsula.



Text-fig. 1.—Map showing the twenty-one Sections of the Eurasian Tundra.

PART III.

Literature and Lists of the Avifauna of the Various Artificial Sections of the Eurasian Tundra.

Signs and Abbreviations.

*	Species that breed regularly.	*hib.*	Species winters.
+	Species breeding in limited numbers.	*litt.*	Occurs along the coast.
×	Species known to breed in Greenland.	*M. K.*	Species found only in open ocean of Kara Sea.
†	Species peculiar to Alaska.	*nid.*	Breeds.
?	An interrogation mark *before* the sign indicates that the identification of the species is in doubt; an interrogation mark *after* the sign expresses doubt as to the correctness of observations on the manner of occurrence of the species in the region under consideration.	*Oc. Gl.*	Species found only in open sea of the Arctic Ocean.
		r.	Rare.
		rr.	Very rare.
		trsv.	Species known as migrants only.
		> <	More or less transitional specimens.
err.	Species of accidental occurrence.	(x)	Hybrid.

Section I. Spitzbergen Archipelago.

The Spitzbergen archipelago is situated between 76° 26′ and 80° 50′ north latitude and between 10° and 32° 30′ longitude east from Greenwich. Its western coast is washed by a branch of the Gulf Stream, thanks to which the surrounding ocean has a much more abundant pelagic fauna and the mainland a much more moderate climate than the eastern shores in the same latitude. Its avifauna has been rather thoroughly studied and we have in Professor König's recent monograph a work that contains an almost exhaustive bibliography, a very detailed systematic and oölogical account of the fauna of the archipelago as well as a critique, at times, perhaps, almost too severe, of the older accounts. The periodic events in the biology of the birds of Spitzbergen are thoroughly treated and a series of excellent photographs enables the reader to gain a precise notion of the conditions governing bird life in Spitzbergen. Of all the older literature I need only draw the reader's attention to the works of Malmgren: (1) Anteckningar till Spetsbergens Fogel-fauna, Öfv. Kongl. Svensk. Vet.-Akad. Förh., 1863, p. 87–126; translated into German, in Journ. f. Ornith., vol. 11, p. 358–387, 447–458, 1863; (2) Nya Anteckningar till Spetsbergens Fogel-fauna, *ibid.*, p. 377–412, 1864, translated into German, *ibid.*, vol. 13, p. 192–216, 261–270, 1865. These contain a splendid description of Spitzbergen from an ornithological point of view, valuable notes on the various places of ornithological interest in the archipelago and on the conditions under which bird life exists there.

The entire Spitzbergen archipelago is included within the tundra; that is, within the different portions of the alpine zone. Its northern parts and a portion of its eastern area are covered with perpetual ice and snow and therefore belong to the *Regio alpina* γ *glacialis* of Wahlenberg. In these regions, save for a few species, as the Snowy Owl and the Ptarmigan, that can survive under the conditions of existence of this section of the alpine zone, the only bird life is that of the gull cliffs, bare of ice and snow, and inhabitated by innumerable Alcids, Gulls and Fulmars. The southern portions and especially their western coasts, thanks to the Gulf Stream, are more favorably situated and should in great part be assigned to the *Regio alpina* β *camporum nudorum*, or even here and there under the most favorable conditions to the *Regio alpina* α *salicum*. It is in the flatter areas (chiefly in the valleys) of these two last sections of the alpine zone of Spitzbergen that a host of Ducks and shorebirds of the archipelago's avifauna flourish, while the cliffs along the shores serve as breeding places for members of the Alcidae, Laridae and Procellariidae.

Literature on Spitzbergen.

1911. **König, Alex.** Avifauna Spitzbergensis. Forschungsreisen nach der Bären-Insel und dem Spitzbergen-Archipel, mit ihren faunistischen und floristischen Ergebnissen. Allgemeiner Theil v. A. Koenig. Spezieller Theil v. Dr. O. le Roi. Bonn, 4to.

This work contains a bibliography of the ornithology of Spitzbergen and Bear Island that is practically exhaustive. I can only add to it the following titles:

1.* 1859. **Newton, A.** Notes on the birds of Spitzbergen. Ibis, ser. 1, vol. 1, p. 199–209, 496–525.
2. 1874. **Eaton, Rev. A. E.** Notes on the fauna of Spitzbergen. Zoologist, ser. 2, vol. 9, p. 3805–3822.
3. 1874. **Drasche-Wartinberg, Dr. Richard von.** Reise nach Spitzbergen im Sommer 1873 mit dem Schooner "Polarstjernen." Wien, 8vo. (Unimportant bird notes.)
4.* 1892. **Cremer, Leo.** Ein Ausflug nach Spitzbergen. 8vo, 80 pp., 12 text-figs., pl., map.
5.* 1894. **Gratzl, A.** Der Besuch der Inseln Jan Mayen und Spitzbergen im Sommer des Jahres 1892. Denkschr. Kais. Akad. Wiss., Wien, math.-nat. Kl., vol. 61, p. 297–308, map.
6.* 1897. **Letellier, M.** A travers la Norvége et Spitsbergen. Paris.
7. 1898. **Rüdiger, W.** Allgemeines über den Verlauf der Expedition nach dem europäischen Nord-Meer an Bord des D. Helgoland. Verh. Ges. f. Erdk., Berlin, p. 430–448. (Unimportant notes on birds.)
8.* 1898. **Gregory, F.** Trans. Liverpool Geogr. Soc.
9. 1899. **Richard, J.** Notes d'excursions au Spitzberg et aux îles voisines. Compte Rendu Soc. Géogr., Paris, p. 66–78. (Unimportant notes on birds.)
10.* 1900. **Andersson, J. G.** Ymer.
11.* 1900. **Bonnar, H. N.** Trans. Scottish Nat. Hist. Soc.; vol. 1.
12.* 1900. **Bruce, W. S.** Spitzbergen 1898 and 1899; voyages with H. S. H. the Prince of Monaco. Scottish Geogr. Mag., Edinburgh, 1900, p. 534–550.
13.* 1902. **Faustini, A.** Riv. Fis.-Math. e Sci. Nat. Pavia.

* I have not had access to works marked with an asterisk (*). Vol. 1 of the Ibis is lacking in our libraries. The titles numbered 4, 5, 6, 8, 10, 11, 12, 13, 15 are cited from the review of Professor König's work published in the Journ. f. Ornith., vol. 60, p. 621–630, 1912, while those numbered 18, 20, 22 are quoted from the Zoological Record.

14. 1904. **Schönrock, A.** Jagdliches von Spitzbergen. Balt. Waidmbl., vol. 4, p. 201–203, 222–224. (Unimportant notes on ornithology.)

15.* 1906. **Baichis, M. de.** Faune et flore du Spitzberg. Bull. Soc. Languedocienne de Géogr., Montpellier, vol. 29, p. 308–325.

16. 1908. **Berkowitz, A.** Reise nach Spitzbergen und von dort nordwärts zum ewigen Eise. Correspondbl. Nat. Ges. Riga, vol. 51, p. 132–134. (Unimportant bird notes.)

17. 1909. **Buturlin, S.** [Interesting finds.] Our Hunting, no. 2, p. 60 (in Russian).

18.* 1909. **Högbom, B.** Snöskata funnen på Spetsbergen. Fauna et Flora, Upsala, no. 4, p. 47.

19. 1910–11. **Münsterhjelm, Ludwig.** Beobachtungen wahrend einer ornithologischen Studien-Reise nach dem Nordpolarmeer und Spitzbergen im Sommer 1910. Oefv. Finska Vet.-Soc. Förh., Helsingfors, vol. 53, no. 20, p. 1–42.

20.* 1911. **Münsterhjelm, Ludwig.** *Falco gyrfalco* funnen på Spetsbergen. Fauna et Flora, Upsala, no. 6, p. 46.

21. 1911. **Zedlitz, Graf O. von.** Ornithologische Notizen von der Zeppelin-Studien-Fahrt Spitzbergen. Sommer 1910. Journ. f. Ornith., vol. 59, p. 300–327.

22.* 1911. **Zedlitz, Graf O. von.** Streifzüge eines Ornithologen in Spitzbergen. Mit Zeppelin nach Spitzbergen. Bilder von der deutschen arktischen Zeppelin-Expedition. Berlin, 8vo, p. 209–226.

23. 1911. **Zedlitz, Graf O. von.** [Ueber *Sterna macrura* und eine ihr nahestehende schwarzfüssige Form von Spitzbergen.] Journ. f. Ornith., vol. 59, p. 164–165.

24. 1911. **Mathey-Dupraz, A.** Notes ornithologiques recueillies au cours des croisières de "l'Ile de France" en Norvège et au Spitzberg. Bull. Soc. Sci. Nat. Neuchâtel, vol. 38, p. 39–55, 3 maps.

25. 1912. **le Roi, O.** Ueber *Somateria mollissima borealis* von Spitzbergen. Ornith. Monatsb., vol. 20, p. 65–66.

26. 1912. **Schalow, H.** Beziehungen zwischen Ost-Grönland und Spitzbergen. Verh. V. Intern. Ornith. Kongr., 1910, p. 77–78.

27. 1912. **(Anon.)** König, Alex. Avifauna Spitzbergensis. Bonn, 1911. Journ. f. Ornith., vol. 60, p. 621–630.

28. 1913. **Grant, W. R. Ogilvie.** Remarks on the Spitsbergen Ptarmigan (*Lagopus hyperboreus*). Bull. Brit. Ornith. Club, vol. 33, p. 32–33.

29. 1913. **Mathey-Dupraz, A.** Notes ornithologiques recueillies au cours de la croisière du "Grosser Kurfürst" au Spitzberg entre le 18 juillet et le 16 août 1911. Bull. Soc. Sci. Nat. Neuchâtel, vol. 39, p. 90–116, 2 maps.

30. 1913. **Lausberg, Carl.** Das Nordland, mit 7 farbigen Tafeln und einem Einbandbild nach Dreifarbenaufnahmen von Geheimrath Prof. Dr. A. Miethe, einer farbigen Gemäldewiedergabe und 228 Abbildungen. Leipzig, 8vo.

(This work contains a popular account of Spitzbergen from various points of view. On p. 378 is a short note on the birds of Spitzbergen, stating that the number of species known from the archipelago is 28 (!). In addition the author tells us that certain birds not usually found in the arctic regions wander accidentally to Spitzbergen. For example, two Russian passengers on their vessel killed there a pair of Albatrosses, species of southern latitudes not hitherto seen in the arctic. I do not doubt that these were merely a pair of Fulmars. On p. 431 the author speaks of the capture of two Cormorants which in reality were probably nothing but Guillemots.)

31. 1921. **Anon.** The Oxford University Expedition to Spitsbergen, 1921. Ibis, ser. 11, vol. 3, p. 757–758.

32.* 1921. **Jourdain, F. C. R.** The Oxford Expedition to Spitsbergen, 1921. Ornithological observations. Nature, vol. 108, p. 151–153.

33.* 1921. **van Oordt, G. T.** Ornithological notes from Spitzbergen and northern Scandinavia 1921. Ardea, vol. 10, p. 129–170, 1 text-fig., 4 pls. Ref. Ibis, 1922, p. 589.

34. 1922. **Jourdain, F. C. R.** The birds of Spitsbergen and Bear Island. Ibis, ser. 11, vol. 4, p. 159–179.

35. 1922. **Jourdain, F. C. R.** Breeding habits of the Barnacle Goose. Auk, vol. 39, p. 166–171.

36*? **Hoel, Ad.** Rapport sur les récentes expéditions Norwégiennes au Spitzberg (1919–1921). Revue de Géogr. Annuelle, vol. 10, nos. 4–5, p. 9.

37.* 1922. **Paget Wilkes, A. H.** On the breeding-habits of the Turnstone as observed in Spitsbergen. British Birds, vol. 15. no. 8, p. 172–179, 5 figs.

38.* 1922. **Paget Wilkes, A. H.** On the breeding-habits of the Glaucous Gull as observed on Bear Island and in the Spitsbergen archipelago. British Birds, vol. 16, no. 1, p. 2–8, 4 figs.

39.* 1922. **van Oordt, G. J., and Huxley, J. S.** Some observations on the habits of the Red-throated Diver in Spitsbergen. British Birds, vol. 16, no. 2, p. 34–46, 8 figs.

40.* 1922. **Johnsen, S.** Vandricks (*Rallus aquaticus*, L.) paa Spitzbergen. Naturen, Bergen, 1922, p. 286–287.

41.* 1923. **Schaanning, H. T. L.** Om endet nyefogler for Spitzbergens omradet. Norsk. Ornith. Tidskr., no. 9, p. 221.

42.* 1923. **Summerhayes and Elton.** Contributions to the ecology of Spitzbergen and Bear Island. Journ. of Ecology, vol. 11, p. 214–286.

43. 1924. **Anon.** Additions to the Natural History Museum. Ibis, ser. 11, vol. 6, p. 825.
(An adult bird and an egg of *Calidris arenaria* (Linné), a *Lagopus hyperboreus* Sundevall, a *Xema sabini* (Sabine), immature, from Spitzbergen.)

44. 1924. **Longstaff, T. G.** Notes from Spitsbergen, 1923. Results of the Merton College Expedition to Spitsbergen 1923, No. 2. Ibis, ser. 11, vol. 6, p. 480–495.

45.* 1924. **Congreve, W. M.** An oölogist in Spitzbergen. Comp. Oölogist, Santa Barbara, California, vol. 1, p. 13–25.

46.* 1925–26. **Schaanning, H. T. L.** Norwegian ornithological bibliography 1591–1924 including Spitzbergen. Norsk. Ornith. Tidskr., ser. 2, vol. 6.

47. 1926. **Montague, A.** Further notes from Spitsbergen. Ibis, ser. 12, vol. 2, p. 136–151.

List of Birds of Spitzbergen.[1]

1. err. **Corvus corax corax** Linné.
2. err. Corone (=Corvus) cornix cornix (Linné).
3. err. Trypanocorax (=Corvus) frugilegus frugilegus (Linné).
4. err. Acgiothus (=Acanthis) hornemanni hornemanni (Holboell).
5. * Plectrophenax nivalis nivalis (Linné).
6. err. **Turdus pilaris** Linné. (Högbom, 1909.)
7. err. Turdus iliacus Linné (=T. musicus Linné). (Jourdain, 1922.)
8. + Saxicola (=Oenanthe) oenanthe leucorrhoa (Gmelin).
9. err. **Anthus** sp.? (von Heuglin).
10. err. Hirundo sp.?
11. err. Cypselus (=Apus) apus apus Linné.
12. err. Upupa epops epops Linné.
13. + Nyctea nyctea (Linné).
14. * Fratercula arctica (Linné).
15. err. Uria troille troille (Linné).
16. * Uria lomvia lomvia (Linné).
17. * Cepphus mandti (Lichtenstein).
18. err. Alca torda Linné. (Mathey-Dupraz, 1913.)

[1] Species not given in Professor König's list (1911) are printed in bold-face type.

19. * Mergulus (=Alle) alle (Linné).
20. err. Megalestris catarrhactes (Linné) (=Stercorarius skua (Brünnich)).
21. + Stercorarius pomarinus (Temminck).
22. * Stercorarius crepidatus Banks (=parasiticus Linné).
23. + Stercorarius longicaudus Vieillot.
24. * Larus glaucus Fabricius (=hyperboreus Gunnerus).
?25. err. **Larus leucopterus** Faber (=**glaucoides** Meyer). (Duc d' Orléans, 1905.)
26. * Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)).
27. + Xema sabini (J. Sabine). (Mathey-Dupraz, 1913; van Oordt and Huxley, 1922; Merton College Exp., Langstaff, 1924.)
28. * Pagophila eburnea (Phipps).
?29. err. **Rhodostethia rosea** (Macgillivray).
30. * Sterna macrura Naumann.
31. + Arenaria interpres (Linné).
32. err. **Haematopus ostralegus** Linné. (Mathey-Dupraz, 1911.)
?33. err. **Eudromias** (=**Charadrius**) **morinellus** (Linné).
34. * Aegialitis (=Charadrius) hiaticula hiaticula (Linné).
35. + Numenius phaeopus (Linné). (Mathey-Dupraz, 1911, 1913.)
36. err. **Tringoides** (=**Tringa**) **macularius** (Linné).
37. + Calidris arenaria (Linné) (=Crocethia alba (Pallas)). (Mathey-Dupraz, 1911; Oxford Exp., 1921, Jourdain, 1922; Binney, 1924; Merton College Exp., Langstaff, 1924.)
38. * Arquatella (=Calidris) maritima maritima (Gmelin).
39. err. Tringa (=Calidris) canutus (Linné).
40. + Pelidna (=Calidris) alpina alpina (Linné). (Mathey-Dupraz, 1911; Oxford Exp., Jourdain, 1922.)
41. err. Scolopax rusticola rusticola Linné.
42. + Phalaropus hyperboreus (Linné) (=lobatus (Linné)).
43. * Crymophilus fulicarius (Linné).
44. err. **Rallus aquaticus aquaticus** Linné. (Johnsen, 1922.)
45. * Lagopus hyperboreus Sundevall.
46. +? Hierofalco (=Falco) islandus (Brünnich). (Münsterhjelm, 1910; Mathey-Dupraz, 1913.)
47. err. Aesalon (=Falco) aesalon (Tunstall). (Münsterhjelm, 1910.)
48. err. Cygnus sp.? (Jourdain, 1922; Langstaff, 1924.)
49. err. *an* †? **Cygnus bewickii bewickii** Yarrell. (Montague, 1926.)
?50. err. **Chen** sp.? (Langstaff, 1924.)
51. * Melanonyx (=Anser) brachyrhynchus (Baillon).
52. * Branta leucopsis (Bechstein).
53. * Branta bernicla bernicla (Linné).
54. err. Mareca (=Anas) penelope (Linné).
55. err. Dafila (=Anas) acuta (Linné).
56. err. Nettion (=Anas) crecca (Linné).
57. * Harelda (=Clangula) glacialis (Linné).
58. err. **Histrionicus histrionicus histrionicus** (Linné). (Mathey-Dupraz, 1911.)
59. + **Oidemia fusca fusca** (Linné). (Mathey-Dupraz, 1911.)
60. + Oidemia nigra nigra (Linné).
61. * Somateria mollissima borealis Brehm.
62. * Erionetta (=Somateria) spectabilis (Linné).
63. * Fulmarus glacialis glacialis (Linné).
64. * Urinator (=Gavia) stellatus (Pontoppidan).

65. err. Urinator (=Gavia) immer (Brünnich). (Merton College Exp., Langstaff, 1924; Montague, 1926.)
66. err. **Urinator (=Gavia) adamsi** (Gray). (Zedlitz, 1910.)
67. err. Pedetaithya (=Podiceps) griseigena griseigena (Boddaert).

In the list of birds of Spitzbergen published by Professor A. König of Bonn, 52 species are enumerated. The latest list, by Jourdain (1922) includes 57, some of which are species restored to the list after having been stricken out by König. I may now add to König's list sixteen species: four are species that König believed should be excluded from his list but which I think should be reinstated, since the reasons for removing them seem to me unfounded as I hope I have shown in the accounts of each. These are: *Corvus corax corax* Linné, *Anthus* sp, *Larus leucopterus* Faber (=*glaucoides* Meyer), *Rhodostethia rosea* Macgillivray, *Eudromias* (=*Charadrius*) *morinellus* (Linné), *Tringoides* (=*Tringa*) *macularius* (Linné). The remaining eight have been found or added by the recent expeditions of Högbom, Professor Mathey-Dupraz, Count von Zedlitz, Johnsen, the Merton College Expedition (Langstaff) and Montague.

Our list of the birds of Spitzbergen shows that in a total of 67 species, 63 have been unquestionably recorded for this archipelago, while four are included doubtfully as indicated with the interrogation points (Nos. 25, 29, 33, 50). Of the total number, 36 species, or 53.73 per cent, have been found to breed here, and the rest, 31 species, or 46.27 per cent, consist of accidental visitors.

Section II. Bear Island.

Bear Island lies between the continent of Europe and the Spitzbergen archipelago, its northern point at the intersection of latitude 74° 30′ north and longitude 19° east of Greenwich. It is a precipitous rock whose southern coast attains a height of 400 meters while the northern coast does not exceed 35 meters. The island therefore decreases gradually in elevation to the northward, its surface representing a tableland with scattered lakes. Professor König's recent monograph likewise treats of Bear Island in the same way as Spitzbergen. As to the literature I wish to call the reader's attention only to the work of G. Swenander, Beiträge zur Fauna der Bären-Insel (Bih. Kongl. Svenska Vet.-Akad. Handl., Stockholm, vol. 26, pt. 4, no. 3), which contains much valuable material on the fauna of the island.

Throughout its entire extent, Bear Island falls within the alpine zone, but on account of its rocky nature, it is chiefly along the shores of the Arctic Ocean, on the "gull cliffs" that its bird life appears very intense.

Literature.

To the list of references in Alexander König's Avifauna Spitzbergensis, 1911, I may add the following:

1. 1910. **Münsterhjelm, L.** Oefv. Finska Vet.-Soc. Forh., Helsingfors, vol. 53, no. 20, p. 1–43.
2. 1911. **Mathey-Dupraz, A.** Notes ornithologiques, recueillies au cours des croisières de "l'Ile de France" en Norvège et au Spitzberg, juillet 1906 et 1910. Bull. Soc. Sci. Nat. Neuchâtel, vol. 38, p. 39–55.
3. 1922. **Jourdain, F. C. R.** The birds of Spitsbergen and Bear Island. Ibis, ser. 11, vol. 4, p. 159–179.
4.* 1922. **Paget Wilkes, A. H.** On the breeding-habits of the Glaucous Gull as observed on Bear Island and in the Spitsbergen archipelago. British Birds, vol. 16, no. 1, p. 2–8, 4 figs.
5.* 1923. **Summerhayes and Elton.** Contributions to the ecology of Spitzbergen and Bear Island. Journ. Ecology, vol. 11, no. 2, p. 214–286.

List of Birds of Bear Island.[1]

?1. err. **Corone** (=**Corvus**) **cornix cornix** (Linné). Observation of Tobiesen (Fries and Nyström, Svensk. Polar-Exp. 1868, p. 40, 1869.)
2. err. Sturnus vulgaris subsp.?
3. err. Loxia curvirostra curvirostra (Linné).
4. * Plectrophenax nivalis nivalis (Linné).
5. err. Anthus spinoletta littoralis (Brehm).
6. err. Turdus iliacus Linné.
7. err. Turdus merula merula (Linné).
8. * Fratercula arctica arctica (Linné).
9. * Uria troille troille (Linné) and Uria troille lacrymans (Valenciennes).
10. * Uria lomvia lomvia (Linné).
11. * Cepphus mandti (Lichtenstein).
12. + Alca torda Linné. (Jourdain, 1922.)
13. * Mergulus (=Alle) alle (Linné).
?14. err. **Megalestris catarrhactes** (Linné) (=**Stercorarius skua** (Brünnich)). (Mathey-Dupraz, 1911, with reservation.)
15. + Stercorarius pomarinus (Temminck).
16. + Stercorarius crepidatus Banks (=parasiticus Linné).
17. err. Stercorarius longicaudus Vieillot.
18. err. Larus marinus Linné.
19. * Larus glaucus Fabricius (=hyperboreus Gunnerus).
20. err. Larus argentatus argentatus Gmelin.
21. * Rissa rissa rissa (Linné) (=tridactyla tridactyla Linné).
22. trsv. *an* hib. Pagophila eburnea (Phipps).
23. * Sterna macrura Naumann.
24. + Arenaria interpres (Linné).
25. err. **Haematopus ostralegus** Linné. (Mathey-Dupraz, 1911.)
26. err. Charadrius pluvialis Linné (=apricarius Linné). (Jourdain, 1922.)
27. + Aegialitis (=Charadrius) hiaticula hiaticula (Linné).
28. err. Numenius phaeopus (Linné).
29. * Arquatella (=Calidris) maritima maritima (Gmelin).
30. + Crymophilus fulicarius (Linné).
31. err. Aesalon (=Falco) aesalon (Tunstall). (Münsterhjelm, 1910.)
32. trsv. Melanonyx (=Anser) brachyrhynchus (Baillon).
33. trsv. **Branta bernicla bernicla** (Linné). (Kolthoff, Kongl. Svenska Vet.-Akad. Handl., Stockholm, vol. 26, no. 9, 1903; Jourdain, 1922.)

[1] Species not given in König's list are printed in bold-face type.

34. err. Nettion (=Anas) crecca (Linné).
35. err. **Mareca (=Anas) penelope** (Linné). (Jourdain, 1922.)
36. err. Dafila (=Anas) acuta (Linné).
37. * Harelda (=Clangula) glacialis (Linné).
38. + Oidemia nigra nigra (Linné).
39. * Somateria mollissima borealis Brehm.
40. + Erionetta (=Somateria) spectabilis (Linné).
41. * Fulmarus glacialis glacialis Linné.
42. * Urinator (=Gavia) stellatus (Pontoppidan).
43. err. Urinator (=Gavia) immer (Brünnich).

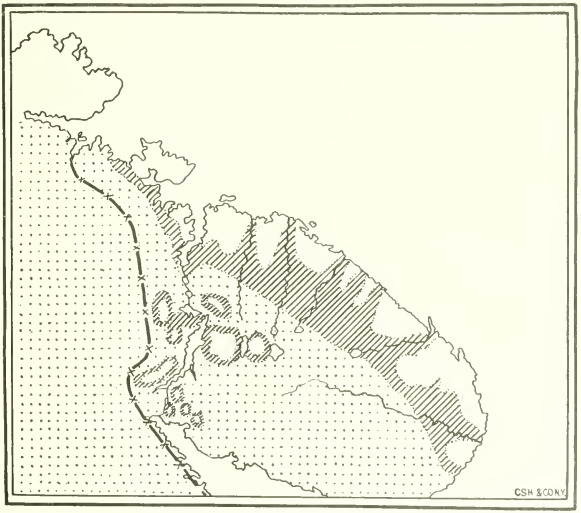
Professor König (1911) lists 38 species for Bear Island. To this number I add two species mentioned by him but not included in his list, namely: (1) (with reservation) *Corone* (=*Corvus*) *cornix cornix* (Linné) observed by Tobiesen, and (2) *Branta bernicla bernicla* (Linné) recorded by Kolthoff and recently by the Oxford Expedition of 1921 (Jourdain, 1922). In addition there are three species entered for the first time in the list of birds of this island through the observations of Mathey-Dupraz, Münsterhjelm and the Oxford Expedition.

An analysis of this list shows us: (1) that of the total number of 43 species recorded for Bear Island, 41 have been positively identified and two are entered as doubtful with interrogation marks (Nos. 1 and 14); (2) that 22 species or 51 per cent have been found to breed and that the remaining 21 species consist chiefly of accidental visitors and a small number of species that pass the island on migration or winter in these latitudes. The number of accidental visitors, which may be placed at 18 species, is rather large for Bear Island but differs in composition from the corresponding list for Spitzbergen. For of these 18 species, 17 comprise birds that reach Bear Island either from the mainland or from the neighboring regions of the Atlantic Ocean, while only one, *Urinator* (=*Gavia*) *immer* (Brünnich) is a Nearctic species.

Section III. Kola Peninsula (Russian Lapland).

The Kola peninsula is situated between 69° 57′ and 66° 31′ north latitude and 28° 51′ and 41° 28′ east longitude. Although its avifauna is well known to me and has long ago been the subject of my special study, I have encountered some difficulties in preparing the list of its birds that compose the tundra fauna of this part of the littoral of the Arctic Ocean. On account of the Gulf Stream, whose eastern branch doubles North Cape and ere turning toward the southwest coasts of Nova Zembla, washes the northern or so-called Murman coast of the Kola peninsula, these shores enjoy a much more temperate climate than the countries in the same latitude to the eastward. Not only are the coasts and bays of the Murman Sea never covered with ice, but in addition the limit of tree and shrub growth extends much farther north in these regions. I had at first planned to include in my list all the species of birds hitherto recorded from the northern

coast of the Kola peninsula, from North Cape to Orloff promontory at the entrance to the White Sea. But since on the western part of this coast, particularly at Sydvaranger, the forest zone (*Regio sylvatica*) reaches the shores of the Arctic Ocean, the list would have to include a number of species that have no association with those of the tundra which are the particular subject of the present study. For this reason I prefer to include in my list only those species that inhabit the alpine zone (tundra) of this section, which extends from the Rybachi peninsula (Fishermen's peninsula) along the north coast of the Kola



TEXT-FIG. 2.—The Kola peninsula. White area = alpine zone; lined area = subalpine zone; dotted area = sylvan zone.

peninsula in a strip at first narrow but gradually increasing in width eastward to the Orloff promontory at the entrance of the White Sea. The alpine zone, in addition to the territory mentioned, also includes the summits of a series of massifs that rise in the interior of the country and project above the shrub zone (*Regio subalpina*). From the map here given (Text-fig. 2) we may see that on account of the warm influence of the Gulf Stream, the alpine zone occupies only a very restricted area along the Murman coast, so that in the western portions the subalpine and even the forest zones reach the

shores of the Arctic Ocean. In the eastern parts, however, where the tundra is of wider extent, it is interrupted chiefly along the rivers that empty into the Arctic Ocean, by a whole series of projections from the northern edge of the subalpine zone, which, like long tongues, extend north to the shores of the Polar Sea.

We should next recall that on account of the climate, influenced by the Gulf Stream and relatively very mild, the subalpine zone on the Kola peninsula is comparatively narrow (not exceeding thirty kilometers at the meridian of Kola) though widening to the eastward, and that the forest zone approaches the shores of the Arctic Ocean, particularly in the western parts. From these causes it results that a very large number of birds characteristic of the subalpine and the forest zones, are of frequent occurrence on the arctic coasts and occasionally breed there in very close proximity to birds of the alpine zone. Thus it results that our list is swollen by a whole series of boreal species that obviously do not belong to the tundra strictly speaking. As I point out in the concluding portion of this paper, I have limited myself to including in my lists only those species that have actually been found to occur in some part of the tundra itself and I have omitted species reported from the neighborhood of the southern edge of this zone but found only in localities really belonging to the subalpine area. Finally I must again point out that the cliffs along the Murman coast afford breeding places in abundance for birds of the arctic species of Alcidae, Laridae and a few Anatidae, as well as for a certain number of other northern forms. Furthermore, a considerable number of species whose breeding grounds lie in Spitzbergen, the Franz Josef archipelago, and to some extent perhaps in Nova Zembla as well, frequent the Murman coast at times other than in the nesting season, chiefly in winter.

By reason of the conditions just described, the list of birds of the Kola peninsula reaches a considerable figure, which has been much increased recently thanks to the splendid collection of 600 specimens of birds secured by B. Kapustin, chiefly at Yokanga (eastern part of the Murman coast) and generously presented to the Zoölogical Museum of the Russian Academy of Sciences. This collection includes a large number of species of accidental occurrence that have probably strayed to these latitudes through following the course of the Gulf Stream during their migration.

Literature.

Pleske, Th. [Critical review of the mammals and birds of the Kola peninsula.] Russian ed., 1887.

Palmén, Y. A. Bidrag till Kannedomen om Sibiriska-Ishafskustens Fogelfauna enligt Vega-Expeditionens jakttagelser och samlingar. "Vega"-Expeditionens Vetenskapliga Jakttagelser, vol. 5, 475 pp., 1887.

The bibliographical lists in these two works may be completed by the addition of the following:

1. 1895. **Rippas, B.** [Account of a trip on the Kola peninsula, executed in 1891 for study of the country between the village of Kandalaksha, the town of Kola and Cathérine Bay, along the projected railway between St. Petersburg and the Murman coast.] St. Pétersbourg, 8vo., in Russian. (Notes on birds, pp. 51, 120.)
2. 1899. **Pearson, H. J.** Notes on the birds observed on the northern parts of the Murman coast, Russian Lapland, in 1899. Ibis, ser. 7, vol. 4, p. 520–538.
3. 1901. **Smirnow, N.** Zur Ornis des Barenzmeeres. An bord des russischen Fangkutters "Pomor." Tagebuchnotizen. Mit Schlusswort von H. Goebel. Ornith. Jahrb, vol. 12, p. 201–212.
4. 1901. **Goebel, H.** Von der Murmanküste (Halbinsel Kola). Zugtabellen für Jeretiki vor der Mündung des Urafjordes (Port Wladimir) und einige andere Küstenplätze. Ornith. Jahrb., vol. 12, p. 213–215.
5. 1902. **Bianchi, V.** [Ornithological material obtained in 1899–1901 by the expedition for the scientific exploration of fisheries at the Murman coast]. Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 263–273 (in Russian).
6. 1902. **Smirnow, N.** [Mammals and birds, hunted in Lapland and in the islands Kolguev and Nova Zembla.] Nature and Hunting, 1902, no. 1, p. 12–15; no. 2, p. 16–20; no. 5, p. 10–11; no. 6, p. 59–60 (in Russian).
7. 1902. **Goebel, H.** Zip Navolok. Ein Brutplatz der *Stellcria dispar, Tringa subarcuata, minuta* und wahrscheinlich *Calidris arenaria* u. a. m. Ornith. Jahrb., vol. 13, p. 107–126.
8. 1902. **Goebel, H., and Smirnow, N.** Die Wintervögel der Murmanküste. Ornith. Jahrb., vol. 13, p. 144–149.
9. 1902–03. **Smirnow, N.** [Ornithological observations made in the southeastern parts of the Barenz Sea.] Nature and Hunting, 1902, no. 10, p. 1–3; no. 11, p. 19–21; no. 12, p. 58–60; 1903, no. 3, p. 18–21; no. 5, p. 19–22; no. 6, p. 14–17; no. 7, p. 23–25 (in Russian).
10. 1903. **Janda, G.** Ein Ausflug nach Nord-Russland. Ornith. Jahrb., vol. 14, p. 98–112.
11. 1903. **Goebel, H.** Auf Alpenschneehühner. Balt. Waidmannsbl., vol. 3, p. 53–56.
12. 1903. **Goebel, H.** [The avifauna of Lapland and the Solowetsky Islands.] Mém. Soc. Nat. St. Pétersbourg, vol. 33, pt. 2, p. 97–137 (in Russian).
13. 1904. **Pearson, Henry J.** Three summers among the birds of Russian Lapland. Appendix I. Birds of Russian Lapland and Kanin peninsula. London, 8vo., p. 192–201.
14. 1904. **Janda, Jiri.** Na Ruském severu. Cestoski dojmy z. R. 1902, zulaštri stick z programmu pruniks českevo gymnasia státnino v Brné za školni rok 1903 1904 v Brné 1904.
15. *1904. **Goebel, H.** [Our northwest borderland—Lapland.] Russian Navigation, no. 12 (in Russian).
16. *1907. **Goebel, H.** Ausführlicher Sammelbericht von der Murmanküste (Zip Navolok, Alexandrowsk u. Ainainseln) und Nowaja Semlja (Kostin Schar) 1901. Zeitschr. f. Ool., vol. 17, p. 51–54.
17. 1907. **Schaanning, H. T. L.** Ostfinmarkens fuglefauna. Ornithologiske meddelelser verdrörende tracterne om Varangerfjorden, specielt Sydvarangers fauna i aarene 1900 1906. Bergens Museums Aarbog, 1907, no. 8, 98 pp.
18. 1908. **Buturlin, S.** [The Bean Geese.] Our Hunting, no. 11, p. 21–28 (in Russian).
19. 1908. **Molchanow, L. A.** [Ornithological investigations undertaken in summer of 1907 in the government of Archangel, on the mainland and at Nova Zembla.] Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 303–314 (in Russian).
20. 1911. **Mawrodiadi, P.** [Observations on birds, cirripeds and gregarines of the Murman Sea. (Account of a voyage, undertaken in summer of the year 1910 to the Murman biological station.)] Bull. Univ. Warsaw, vol. 3, p. 1–21 (in Russian).

(Birds, p. 11; the author mentions specimens of *Fratercula arctica glacialis* (Leach) taken from

the colony at the Ainowski Islands, and considers the two forms identical on account of the similarity in the formation of their skulls.)

21. 1913. **Grave, G.** [Account of a journey into Russian Lapland.] Mess. Ornith., 1913, p. 383–385 (in Russian).
22. 1916. **Walch, Dr. B. S.** Notes on expeditions. Mess. Ornith., 1916, no. 3, p. 195.
23. 1925. **Fedjushin, A. W.** [Contributions to the ornithology of the Murman coast.] Mem. Univ. of White Russia, Minsk, nos. 8, 9, 10 (in Russian).
24. 1926. **Fedosow, A.** [The island Kolguev.] The Ukrainia hunter and fisherman, 1926, no. 6.
25. 1926. **Serebrowsky, P.** Uebersicht der in Russland vorkommenden Formen von *Lagopus mutus* Montin. Journ. f. Ornith., vol. 74, p. 691–698.
26. 1926. **Bolam, George.** Steller's Eider, *Polysticta stelleri* (Pallas) breeding in Norway. Ibis, ser. 12, vol. 2, p. 440–441.
27. 1926. **Robinson, H. W.** The nesting of Steller's Eider in Norway. Ibis, ser. 12, vol. 2, p. 631.
28. 1926. **Jourdain, F. C. R.** The nesting of Steller's Eider in Norway. Ibis, ser. 12, vol. 2, p. 832–833.
29. 1926. **Serebrowsky, P.** Neue Formen des Moorschneehuhnes (*Lagopus lagopus* (L.)). Journ. f. Ornith., vol. 74, p. 511–515.
30. 1926. **Smirnow, N.** [Spring observations of birds in the mouth of the White Sea.] Comptes Rendus de l'Acad. Sci. St. Pétersbourg, 1926, p. 32–34 (in Russian).
31. 1926. **Jourdain, F. C. R.** Breeding of Steller's Eider (*Polysticta stelleri*) in Norway. Norsk Ornith. Tidskr., ser. 2, vol. 7, p. 204.
32. 1927. **Bunyard, P. F.** The nesting of Steller's Eider in Norway. Ibis, ser. 12, vol. 3, p. 177–178.

List of Birds of the Murman Coast.[1]

1. * (nid. litt.) Corvus corax corax Linné.
2. \+ **Corone (=Corvus) cornix cornix** (Linné). (Goebel and Smirnow, Ornith. Jahrb., vol. 13, p. 45, 1902.)
3. err. **Trypanocorax (=Corvus) frugilegus frugilegus** (Linné). (*Ibid.*, p. 47; Bianchi, Annuaire Mus. Zool. St. Pétersbourg, vol. 7, p. 263, 1902; male, 8 April 1920; female, 16 April 1921, Yokanga, coll. Kapustin.)
4. err. **Sturnus vulgaris intermedius** Prazak. (Female, 11 May 1921, Yokanga, coll. Kapustin.)
5. * **Aegiothus (=Acanthis) hornemanni exilipes** (Coues). (Pearson, 1904; specimen in our Zoöl. Mus. taken by the Scientific Expedition to Murman Coast under Knipowich—Bianchi, 1902, under *Aeg. linaria* (Linné). Numerous specimens in Kapustin coll.)
6. ?+ Aegiothus (=Acanthis) linaria linaria (Linné).
7. err. **Passer domesticus domesticus** (Linné). (Female, 30 October 1921, Yokanga, coll. Kapustin.)
8. err. **Passer montanus montanus** (Linné). (Male, 21 May 1921; female, 16 June 1920, Yokanga, coll. Kapustin.)
9. err. **Pyrrhula pyrrhula pyrrhula** (Linné). (Male, 7 December 1923; male and female, 10 October 1920, Yokanga, coll. Kapustin.)
10. * Plectrophenax nivalis nivalis (Linné).
11. * Calcarius lapponicus lapponicus (Linné).
12. err. **Alauda arvensis arvensis** (Linné). (Male, 4 April 1920; male, 12 April 1925; female, 25 January 1925, Yokanga, coll. Kapustin.)
13. * Otocorys (=Eremophila) alpestris flava (Gmelin).
14. \+ Anthus pratensis (Linné).

[1] Species not included in Professor Palmén's list are printed in bold-face type.

15. * Anthus cervinus (Pallas).
16. * (nid. litt.) Anthus spinoletta littoralis (Brehm).
17. + Motacilla alba alba Linné.
18. +? **Budytes flava flava** (Linné). (Male, 20 May; female, 21 May 1920, Yokanga, coll. Kapustin.)
19. + **Budytes flava borealis** Sundevall.
20. err. **Periparus (=Parus) ater ater** (Linné). (20 October 1923, Yokanga, coll. Kapustin.)
21. err. **Aegithalos caudatus caudatus** (Linné). (14 October 1923, Yokanga, coll. Kapustin.)
22. err. **Hedimela atricapilla atricapilla** (Linné) (=**Muscicapa hypoleuca** (Pallas)). (Male, 18 May 1923, Yokanga, coll. Kapustin.)
23. + Phylloscopus trochilus (Linné).
24. + Acanthopneuste (=Phylloscopus) borealis borealis (Blasius).
25. + Turdus pilaris Linné.
26. + Turdus iliacus Linné (=T. musicus Linné).
27. + Saxicola (=Oenanthe) oenanthe oenanthe (Linné).
28. + Cyanecula (=Luscinia) svecica svecica (Linné).
29. err. **Phoenicurus phoenicurus phoenicurus** (Linné). (Male, 18 May 1923, Yokanga, coll. Kapustin.)
30. err. Hirundo rustica rustica (Linné).
31. err. **Cypselus (=Apus) apus apus** (Linné). (25 August 1922, Swjatoi Nos, coll. Kapustin.)
32. + Nyctea nyctea (Linné).
33. + Asio accipitrinus (Pallas) (=flammeus (Pontoppidan)).
34. * litt. nid. Fratercula arctica (Linné). (Mawrodiadi, 1911.)
35. * litt. nid. Uria troille troille (Linné) et Uria troille lacrymans (Valenciennes).
36. * litt. nid. Uria lomvia lomvia (Linné).
37. * litt. nid. Cepphus grylle (Linné).
38. litt. hib. **Cepphus mandti** (Lichtenstein). (Smirnow, 1901; Goebel, 1901.)
39. * litt. nid. Alca torda Linné.
40. litt. hib. Mergulus (=Alle) alle (Linné).
41. err. **Megalestris catarrhactes** (Linné) (=**Stercorarius skua** (Brünnich)). (Goebel, 1903.)
42. + Stercorarius pomarinus (Temminck).
43. * Stercorarius crepidatus Banks (=parasiticus Linné).
44. + Stercorarius longicaudus (Vieillot).
45. + litt. Larus marinus Linné.
46. + Larus fuscus fuscus Linné.
47. err. litt. hib. **Larus argentatus antelius** (Iredale). (Smirnow, 1901.)
48. * litt. Larus glaucus Fabricius (=hyperboreus Gunnerus).
?49. err. litt. hib. **Larus leucopterus** Faber (=**glaucoides** Meyer). (Goebel, 1903; Smirnow, 1901; Goebel and Smirnow, 1902.)
50. + **Larus argentatus omissus** Sushkin.
51. + Larus canus canus Linné.
52. * litt. nid. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)).
53. litt. hib. **Xema sabini** (J. Sabine). (Smirnow, 1901.)
54. litt. hib. **Pagophila eburnea** (Phipps). (Goebel, 1903; adult, 23 January 1918, Yokanga, coll. Kapustin.)
55. err. **Sterna hirundo hirundo** Linné. (Bianchi, 1902.)
56. * Sterna macrura Naumann.
57. * litt. nid. Arenaria interpres (Linné).
58. * litt. Haematopus ostralegus Linné.

59. err. **Squatarola helvetica** (=squatarola) (Linné). (Female, 8 June 1918, Yokanga, coll. Kapustin.)
60. + Charadrius pluvialis Linné (=apricarius Linné).
61. * Eudromias (=Charadrius) morinellus (Linné).
62. * litt. Aegialitis (=Charadrius) hiaticula tundrae Lowe.
63. + Numenius phaeopus (Linné).
64. + Limosa lapponica lapponica (Linné).
65. + Totanus fuscus (Linné) (=Tringa erythropus (Pallas)).
66. + litt. Totanus calidris (Linné) (=Tringa totanus Linné).
67. + Tringoides (=Tringa) hypoleucos (Linné).
68. + Rhyacophilus (=Tringa) glareola (Linné).
69. + Pavoncella (=Philomachus) pugnax (Linné).
70. trsv. **Calidris arenaria** (Linné) (=**Crocethia alba** (Pallas)). (Goebel, 1903.)
71. * Limonites (=Calidris) minuta minuta (Leisler).
72. * Limonites (=Calidris) temminckii (Leisler).
73. * litt. nid. Arquatella (=Calidris) maritima maritima (Gmelin).
74. litt. trsv. Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)).
75. litt. trsv. Tringa (=Calidris) canutus Linné.
76. + Pelidna (=Calidris) alpina alpina (Linné).
77. + Gallinago (=Capella) gallinago gallinago (Linné). (Pearson, 1899, p. 317, *sub* Gallinago major.)
78. * Phalaropus hyperboreus (Linné) (=lobatus (Linné)).
79. litt. hib. **Crymophilus fulicarius** (Linné).
80. err. **Turtur** (=**Streptopelia**) **turtur turtur** (Linné). (Juv., 11 October 1923, Yokanga, coll. Kapustin.)
81. + Lagopus lagopus kapustini Serebrowsky.
82. * Lagopus mutus mutus Montin.
83. + Hierofalco gyrfalco (Linné) (=Falco rusticolus Linné).
84. * Falco peregrinus griseiventris Brehm.
85. + Aesalon (=Falco) aesalon (Tunstall).
86. + litt. Haliaëtus (=Haliaeëtus) albicilla (Linné).
87. + Archibuteo (=Buteo) lagopus lagopus (Brünnich).
88. + **Astur palumbarius** (Linné) (=**Accipiter gentilis** (Linné)).
89. + Cygnus cygnus cygnus (Linné).
90. err. litt. trsv. Cygnus bewickii bewickii Yarrell.
?91. + Melanonyx (=Anser) brachyrhynchus (Baillon).
92. + Melanonyx arvensis arvensis (Naumann) (=Anser fabalis (Latham)). (Buturlin, Our Hunting, 1908, no. 11, p. 27, in Russian.)
93. trsv. Anser albifrons (Scopoli).
94. + **Anser erythropus** Linné.
95. trsv. **Branta leucopsis** (Bechstein).
96. trsv. **Branta bernicla bernicla** (Linné).
97. + Mareca (=Anas) penelope (Linné).
98. + Nettion (=Anas) crecca (Linné).
99. + Dafila (=Anas) acuta (Linné).
100. + Fuligula (=Nyroca) marila (Linné).
101. * Harelda (=Clangula) glacialis (Linné).
?102. err. **Histrionicus histrionicus histrionicus** (Linné). (Goebel and Smirnow, 1902.)
103. + Oidemia fusca fusca (Linné).

104. + Heniconetta (=Polysticta) stelleri (Pallas).
105. * litt. Somateria mollissima mollissima (Linné).
106. litt. hib., nid. rr. Erionetta (=Somateria) spectabilis (Linné).
107. + **Merganser** (=**Mergus**) **merganser merganser** (Linné).
108. + Merganser (=Mergus) serrator (Linné).
109. err. **Mergus albellus** Linné. (Goebel, 1901, 1903.)
110. * litt. Phalacrocorax carbo (Linné).
111. + litt. **Phalacrocorax graculus graculus** (Linné). (Smirnow, 1901; Goebel and Smirnow, 1902.)
112. err. Sula (=Moris) bassana (Linné).
113. Oc. Gl. Fulmarus glacialis glacialis (Linné).
114. * Urinator (=Gavia) stellatus (Pontoppidan).
115. * Urinator (=Gavia) arcticus arcticus (Linné).
116. hib. litt. **Urinator** (=**Gavia**) **immer** (Brünnich). (Fedosow, 1926.)
117. hib. litt. Urinator (=Gavia) adamsi (Gray). (Fedjushin, 1925.)

My list of birds from the tundra of the Kola peninsula reaches a total of 117 species, and exceeds Professor Palmén's list for the same region by 36 species, most of them added on the basis of the recent observations of Goebel and Smirnow and the collections of Kapustin. Three of this number still require definite confirmation and are here included with an interrogation mark; these are: *Larus leucopterus* Faber (=*glaucoides* Meyer) and *Histrionicus histrionicus histrionicus* (Linné) recorded by the naturalists just mentioned, and *Melanonyx* (=*Anser*) *brachyrhynchus* (Baillon) added previously by myself. Of the total of 117, at least 76 (or 64.4 per cent) are known to breed (30 in considerable abundance and 46 in limited numbers) and 41 (or 35.6 per cent) do not breed in this region. Among these last I have also included *Calidris arenaria* (Linné) (=*Crocethia alba* (Pallas)) which probably does not occur on the Murman coast except during the migration period, but the conditions governing its occurrence there are still insufficiently known.

Section IV. Kanin Peninsula and Tschesskaja Bay.

The Kanin peninsula is situated to the east of the entrance to the White Sea, between latitude 66° 30′ and 68° 39′ north and between longitude 43° 15′ and 46° 27′ east of Greenwich. Its eastern shore is washed by Tschesskaja Bay. Its avifauna is still imperfectly known. In recent times it has been visited by Zitkow and by Pearson (*ll. cc.*); in addition Smirnow (*l.c.*) has published some important notes on the winter fauna of the Arctic Ocean that bounds this peninsula in these latitudes. Nowhere does the northern edge of the forest zone extend to the Kanin peninsula, according to the map in the work by Professor Tanfiljeff ([The limit of forest growth in Arctic Russia], Odessa, 1911, in Russian), and it is only occasional oases of dwarfed trees that occur sporadically in the southern parts of the peninsula. According to Jacobi's paper (Trav. Soc. Nat. Univ. Kasan, vol. 23, pt. 1, p. 70, 1891) the most northern of these oases of trees are

found slightly under 67° north latitude. The tundra proper occupies only the most northern part of the peninsula (from about 68° 30′ on the west coast to 67° 40′ on the east coast); but its central area, of considerable extent too, is likewise bare of trees, shrubs and bushes, and is broken, particularly along the courses of rivers and streams, by islands of birch woods and alder groves of good height belonging to the zone that Russian botanists call "wooded tundra" and that Wahlenberg calls the subalpine region. In the places where the typical tundra is broken by these oases, the fauna is at once increased by a whole series of species of birds characteristic of the subalpine zone (as *Cyanecula, Phylloscopus, Turdus, Acanthis, Totanus* and a few ducks and geese), and we must therefore take these into consideration. The northern part of the peninsula belonging to the alpine zone is for the greater part included in the lower section of this zone, *Regio alpina α salicum*, but probably also to some degree in the middle section, *Regio alpina β camporum nudorum*. I must add further that the elevation of the shores of the Arctic Ocean along the coasts of the Kanin peninsula does not exceed 12 to 15 meters according to Zitkow, and there are no cliffs whatsoever. For this reason species living on "gull cliffs" are not found breeding there and occur only in the open sea of these latitudes at times other than the breeding season, chiefly in winter.

Literature.

See **Palmén, J. A.** Bidrag Sibir. Ishafskust Fogelf., Vega Exped., p. 477, 1887.

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12. 1926. **Smirnow, N.** [Spring observations of birds in the mouth of the White Sea.] Comptes Rendus de l'Acad. Sci. St. Pétersbourg, 1926, p. 32–34 (in Russian.)

List of Birds of the Kanin Peninsula.[1]

1. \+ Corvus corax corax Linné.
2. \+ Aegiothus (=Acanthis) sp.?
3. err. **Passer montanus montanus** (Linné). (Pearson, 1904.)
4. * Plectrophenax nivalis nivalis (Linné).
5. * Calcarius lapponicus lapponicus (Linné).
6. * Otocorys (=Eremophila) alpestris flava (Gmelin).
7. \+ Motacilla alba alba Linné.
8. \+ **Budytes flava borealis** Sundevall. (Zitkow, 1904; Pearson, 1904.)
9. * Anthus cervinus (Pallas).
10. \+ Phylloscopus trochilus (Linné).
11. \+ Turdus pilaris Linné.
12. \+ Turdus iliacus Linné (=musicus Linné).
13. \+ Saxicola (=Oenanthe) oenanthe oenanthe (Linné).
14. \+ Cyanecula (=Luscinia) svecica svecica (Linné).

?15. err. **Dryobates leuconotus leuconotus** (Bechstein). (Smirnow, 1901.)

16. \+ Nyctea nyctea (Linné).
17. litt. hib. Uria lomvia lomvia (Linné).

?18. hib. an nid.? **Cepphus grylle** (Linné). (Smirnow and Goebel, 1901.)

19. \+ Stercorarius pomarinus (Temminck).
20. \+ Stercorarius crepidatus Banks (=parasiticus Linné).
21. * Stercorarius longicaudus (Vieillot).
22. * Larus marinus Linné.
23. * Larus argentatus antelius (Iredale).
24. \+ Larus glaucus Brünnich (=hyperboreus Gunnerus).
25. \+ Larus canus canus Linné.
26. litt. hib. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)).
27. litt. hib. **Pagophila eburnea** (Phipps). (Smirnow, 1901.)
28. * Sterna macrura Naumann.
29. * Haematopus ostralegus Linné.
30. \+ Squatarola helvetica (Linné) (=squatarola (Linné)).
31. \+ Charadrius pluvialis Linné (=apricarius (Linné)). (Zograf, 1881.)
32. * Aegialitis (=Charadrius) hiaticula tundrae Lowe.
33. \+ Numenius sp.?

?34. \+ Limosa lapponica lapponica (Linné).

35. \+ Rhyacophilus (=Tringa) glareola (Linné).
36. \+ Pavoncella (=Philomachus) pugnax (Linné).
37. \+ Limonites (=Calidris) temminckii (Leisler).
38. \+ Pelidna (=Calidris) alpina alpina (Linné).
39. \+ Gallinago (=Capella) gallinago gallinago (Linné).
40. * Phalaropus hyperboreus (Linné) (=lobatus (Linné)).
41. \+ Lagopus lagopus (Linné) subsp.?

?42. * Lagopus mutus Montin subsp.? (*Teste* Aubel, 1874.)

43. * Hierofalco gyrfalco (Linné) (=Falco rusticolus Linné).
44. \+ Haliaëtus (=Haliaecëtus) albicilla (Linné).

[1] Species not given in Professor Palmén's list are printed in bold-face type. Since for lack of material Palmén had to combine the notes for the Kanin peninsula, Kolguev Island and the Lower Pechora, a strict comparison of my list with his is not possible. I therefore merely indicate by heavy type the species wholly absent from his list, but I must confess that a certain number of species included in his list have not been found in the Kanin peninsula.

45. + **Archibuteo** (= **Buteo**) **lagopus lagopus** (Brünnich). (Pearson, 1904.)
?46. + Melanonyx segetum segetum (Gmelin) (= Anser fabalis (Latham)). (Pearson, 1904.)
47. + Anser albifrons (Scopoli).
48. + Anser erythropus Linné.
49. + Mareca (= Anas) penelope (Linné).
50. + Nettion (= Anas) crecca (Linné).
51. + Dafila (= Anas) acuta (Linné).
52. + **Fuligula** (= **Nyroca**) **marila marila** (Linné). (Pearson, 1904.)
53. * Harelda (= Clangula) glacialis (Linné).
54. + Oidemia fusca fusca (Linné).
55. + ? Oidemia nigra nigra (Linné).
56. + **Somateria mollissima mollissima** (Linné). (Pearson, 1904.)
57. + Erionetta (= Somateria) spectabilis (Linné).
58. hib. Oc. Gl. Fulmarus glacialis glacialis (Linné).
59. *r. Urinator (= Gavia) stellatus (Pontoppidan).
60. *r. Urinator (= Gavia) arcticus arcticus (Linné).
?61. * Urinator (= Gavia) adamsi (Gray).

The list of birds of the Kanin peninsula reaches a total of 61 species, eight of which are not in Professor Palmén's list while the six following are included with interrogation marks: *Dryobates leuconotus leuconotus* (Bechstein), seen but not taken by Smirnow; *Cepphus grylle* (Linné), possibly confused by the same naturalist with *Cepphus mandti* (Lichtenstein); *Limosa lapponica lapponica* (Linné); *Lagopus mutus* subsp.?, the subspecies of which is not determined; *Melanonyx segetum segetum* (Gmelin) (= *Anser fabalis* (Latham)); *Urinator* (= *Gavia*) *adamsi* (Gray).

Of the total number of 61 species recorded from the Kanin peninsula, at least 54 species (88.52 per cent) have been found breeding (16 regularly, and 38 occasionally) and seven (or 11.48 per cent) are of accidental occurrence. From this last figure should, however, be subtracted five species that occur more or less regularly at sea outside the breeding season so that the actual number of accidental visitors is no more than two.

Section V. Kolguev Island.

Kolguev Island lies in the eastern part of Barenz Sea, approximately between 68° 15′ and 69° 55′ north latitude and 48° and 49° 38′ east longitude. It is nearly 80 kilometers long and 50 kilometers in greatest width, and consists entirely of beds of sedimentary rock. It appears as a low-lying island which on the side toward the Arctic Ocean reaches an elevation of not more than seven to twenty meters while its highest hills do not exceed 75 meters. The entire island is covered by alpine vegetation, with many small lakes and pools of water formed by the melting of the snow. An analysis of its flora shows that it falls in the lower section of the alpine zone (*Regio alpina* α *salicum*); its thickets of willows and dwarf birch, *Betula nana*, occasionally reach a height of 60

centimeters. Only in the northern portions of the island are there areas quite bare of vegetation that may be referred to the middle section of the alpine zone (*Regio alpina β camporum nudorum*). There are no "gull rocks" whatever.

Literature.

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14. *1917. **Chapman, Abel.** Brent Geese. Scottish Nat., 1917, p. 70–75 (ref. Ibis, 1917, p. 621). (On Kolguev both forms of *Branta berniela* (Linné) breed.)
15. 1926. **Tolmacheff, A.** [The avifauna of the island Kolguev.] Manuscript.
16. 1926. **Fedosow, A.** [The island Kolguev.] The Ukraina Hunter and Fisherman, vol. 4, nos. 6, 7, 8, 9, Kharkow (in Russian).
17. 1927. **Tolmacheff, A.** Eine Sommerreise nach der Insel Kolgujev i. J. 1925. Geogr. Annalen, pt. 1–2, p. 67–80.

Note.—In the Zoölogical Record for the year 1896, I have just found the following error: Trevor-Battye, Aubyn. (On the common Guillemot in Kolguev), Ibis, 1896, p. 155. In the article cited, Trevor-Battye corrects an error in identification of the Common Guillemot seen on the island Hornö near Vardö, and recorded in his book, Ice-bound on Kolguev, p. 20, as Brünnich's Guillemot. This note does not refer to Kolguev Island at all, and the mistake in the Record can only be explained by the title of Trevor-Battye's work, Ice-bound on Kolguev.

List of Birds of Kolguev Island.[1]

1. err. Aegiothus (=Acanthis) sp.?
2. * Plectrophenax nivalis nivalis (Linné).
3. * Calcarius lapponicus lapponicus (Linné).
4. * Otocorys (=Eremophila) alpestris flava (Gmelin).
5. + Motacilla alba alba Linné.
6. + Anthus pratensis (Linné).
7. * Anthus cervinus (Pallas).
8. err. **Saxicola** (=**Oenanthe**) **oenanthe oenanthe** (Linné).
9. + Cyanecula (=Luscinia) svecica svecica (Linné).[2]
10. err. Chelidon (=Delichon) urbica urbica (Linné).
11. err. **Cypselus** (=**Apus**) **apus apus** Linné. (Smirnow, 1902, 1903.)
12. + Nyctea nyctea (Linné).
13. litt. hib. Uria lomvia lomvia (Linné).
14. err. **Megalestris catarrhactes** (Linné) (=**Stercorarius skua** (Brünnich)). (Smirnow, 1902, 1903.)
15. + Stercorarius pomarinus (Temminck).
16. * Stercorarius crepidatus (Banks) (=parasiticus Linné).
17. + Stercorarius longicaudus (Vieillot).
18. + Larus marinus Linné.
19. * Larus argentatus antelius Iredale.
20. * Larus glaucus Brünnich (=hyperboreus Gunnerus).
21. litt. hib. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)).
22. litt. hib. Pagophila eburnea (Phipps).
23. + **Xema sabini** (J. Sabine). (Fedosow, 1926, sub *L. minutus.*)
24. + Sterna macrura Naumann.
25. * Arenaria interpres (Linné).
26. * Squatarola helvetica (Linné) (=squatarola (Linné)).
27. + Charadrius pluvialis Linné (=apricarius Linné).
28. * Eudromias (=Charadrius) morinellus (Linné).
29. * Aegialitis (=Charadrius) hiaticula tundrae Lowe.
30. err. **Limosa lapponica lapponica** (Linné).
31. err. **Numenius phaeopus** (Linné).
?32. err. **Totanus calidris** (Linné) (=**Tringa totanus** Linné), or **Totanus fuscus** (Linné) (=**Tringa erythropus** (Pallas)). (Smirnow, 1902, 1903.)
33. err. **Rhyacophilus** (=**Tringa**) **glareola** (Linné). (Buturlin, Bull. Russ. Geogr. Soc., vol. 39, p. 234, 1903.)
34. * Pavoncella (=Philomachus) pugnax (Linné).
35. trsv. **Calidris arenaria** (Linné) (=**Crocethia alba** (Pallas)).
36. * Limonites (=Calidris) minuta minuta (Leisler).
37. * Limonites (=Calidris) temminckii (Leisler).
38. + Arquatella (=Calidris) maritima maritima (Gmelin).
39. trsv. **Ancylochilus subarquatus** (Güldenstädt) (=**Calidris ferruginea** (Brünnich)).
40. * Pelidna (=Calidris) alpina alpina (Linné).

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[1] Species not listed by Schalow are printed in bold-face type.

[2] Feilden (in Markham's A Polar Reconnaissance, being the Voyage of the "Isbjörn," p. 333, 1881) states that between Kolguev Island and Nova Zembla, in latitude 70° 6′ north and longitude 48° 40′ east, a Blue-throat appeared aboard the vessel, that he identified as *Ruticilla wolfi*, but it was undoubtedly a *Cyanecula* (=*Luscinia*) *svecica svecica* (Linné).

41. * Phalaropus hyperboreus (Linné) (=lobatus (Linné)).
42. litt. nid.? Crymophilus fulicarius (Linné).
43. * Lagopus lagopus (Linné) subsp.?
44. ? **Lagopus mutus**? or **Lagopus hyperboreus** Sundevall? (Fedosow, 1926.)
45. * **Falco peregrinus griseiventris** Brehm.
46. + **Aesalon** (=**Falco**) **aesalon** (Tunstall).
47. * Cygnus bewickii bewickii Yarrell.
48. + **Melanonyx** (=**Anser**) **neglectus** (Sushkin).
49. * Melanonyx arvensis arvensis (Brehm) (=Anser fabalis (Latham)).
50. * Melanonyx segetum segetum (Gmelin) (=Anser fabalis (Latham)).
51. * Anser albifrons (Scopoli).[1]
52. + **Branta leucopsis** (Bechstein).
53. * Branta berniela berniela (Linné).
54. + **Mareca** (=**Anas**) **penelope** (Linné).
55. + Fuligula (=Nyroca) marila marila (Linné).
56. err. **Fuligula** (=**Nyroca**) **fuligula** (Linné).
57. * Harelda (=Clangula) glacialis (Linné).
58. + Oidemia fusca fusca (Linné).
59. + Oidemia nigra nigra (Linné).
60. + Somateria mollissima mollissima (Linné).
61. * Erionetta (=Somateria) spectabilis (Linné).
62. + Merganser (=Mergus) merganser merganser (Linné).
63. + Merganser (=Mergus) serrator (Linné).
64. hib. Oc. Gl. Fulmarus glacialis glacialis (Linné).
65. * Urinator (=Gavia) stellatus (Pontoppidan).
66. * Urinator (=Gavia) arcticus arcticus (Linné).
67. * Urinator (=Gavia) adamsi (Gray).

The list of the birds of Kolguev published by Schalow (*l.c.*, p. 277) in 1905 gives 51 species as in his opinion certainly known for the island. From this list I believe *Larus leucopterus* Faber (=*glaucoides* Meyer) should be dropped, since it is obviously included on the authority of Smirnow although in his latest paper the latter author himself expresses his doubts as to the correctness of the identification of this species. I must next restore to the list eleven species that were eliminated by Schalow without sufficient cause, namely, *Saxicola* (=*Oenanthe*) *oenanthe oenanthe* (Linné), *Calidris arenaria* (Linné) (=*Crocethia alba* (Pallas)), *Ancylochilus subarquatus* (Güldenstädt) (=*Calidris ferruginea* (Brünnich)), *Limosa lapponica lapponica* (Linné), *Numenius phaeopus* (Linné), *Falco peregrinus griseiventris* Brehm, *Aesalon* (=*Falco*) *aesalon* (Tunstall), *Melanonyx* (=*Anser*) *neglectus* Sushkin, *Branta leucopsis* (Bechstein), *Mareca* (=*Anas*) *penelope* (Linné), *Fuligula* (=*Nyroca*) *fuligula* (Linné).

By the addition of six more, we reach a total of 67 species that have been observed hitherto on Kolguev Island and its vicinity.

[1] The Dwarf Goose (*Anser erythropus* Linné) was recorded for Kolguev Island by Dresser (Eggs Birds Europe, p. 538, 1910) but probably in error,—see account of this species.

The present list shows: (1) that of the total of 67 species recognized from Kolguev Island, 66 have been positively identified while one (listed with an interrogation mark) requires further confirmation; (2) that 50 species (74.62 per cent) have been found to breed there and 17 (25.38 per cent) are wintering species, migrants or accidental visitors.

Section VI. The Mouth of the Pechora.

The section including the mouth of the Pechora takes in that part of the Eurasian tundra situated along the Barenz Sea, between the east coast of Tschesskaja Bay and the lower course of the Pechora (Malozemelskaja tundra) on the west and from the Pechora to the entrance of Jugor Strait on the east (Bolschezemelskaja tundra). This area is practically included between north latitude 66° 40′ and 69°, and between east longitude 47° 40′ and 60° from Greenwich. The northern limit of the forest region, following the course of the Pescha River, nearly reaches the Arctic Ocean, gradually rises to the west, and along the Soima River exceeds the 67th parallel by almost 25′. Passing the lower course of the Pechora at the same or even a slightly higher latitude it then falls away eastward to latitude 66° 25′ north. The subalpine zone extends along the Pechora River almost to Alexejevka (in latitude 67° 54′ north) and the alpine zone commences in the region of the mouth of the Jushina River (an affluent of the Pechora) and of Stanovajalachta. My information does not suffice for defining the precise extent of the different sections of the alpine zone in these latitudes. At the mouth of the river and on the Guljajevskija-koschki, that extend between the promontories Rousskij-Zavorot and Tschernaja-Lopatka, sand dunes with very slight herbaceous vegetation predominate.

As outstanding works that even up to the present time have not lost their value and offer a mass of most important details on the ornithology of these regions, I should mention the works of Seebohm and Harvie-Brown (Ibis, 1876, p. 105–126, 215–230, 289–311, 434–456; appendix, *ibid.*, 1877) and especially Seebohm's book, Siberia in Europe (London, 1880).

Literature.

See **Palmén, J. A.** Sibir. Ishafskust Fogelfauna, p. 478, 1887, and the following supplementary papers.

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2. 1908. **Buturlin, S.** Bean Geese of Asia. *Ibid.*, vol. 18, p. 555–561.
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5. 1911. **Buturlin, S.** *Larus affinis taimyrensis*, subsp. nova. Mess. Ornith., 1911, p. 149 (in Russian).
6. ?* **Borissow, A.** [With the Samoyèdes. From Pinéga to the Kara Sea. Account of a journey of an artist with reproduction of 36 of his pictures.] St. Pétersbourg, 8vo, p. 55 (in Russian).

List of Birds of the Pechora.[1]

1. \+ Corvus corax corax Linné.
2. \+ Aegiothus (=Acanthis) hornemanni exilipes (Coues).
3. \+? Aegiothus (=Acanthis) linaria linaria (Linné).
4. * Plectrophenax nivalis nivalis (Linné).
5. * Calcarius lapponicus lapponicus (Linné).
6. * Otocorys (=Eremophila) alpestris flava (Gmelin).
7. \+ Motacilla alba alba Linné.
8. \+ Budytes citreola citreola (Pallas).
9. \+ Anthus pratensis (Linné).
10. * Anthus cervinus (Pallas).
11. \+ Phylloscopus trochilus (Linné).
12. \+ Phylloscopus tristis Blyth.
13. \+ Turdus pilaris Linné.
14. \+ Turdus iliacus Linné (=musicus Linné).
15. \+ Saxicola (=Oenanthe) oenanthe oenanthe (Linné).
16. * Nyctea nyctea (Linné).
17. \+ Stercorarius pomarinus (Temminck).
18. * Stercorarius crepidatus Banks (=parasiticus Linné).
19. * Stercorarius longicaudus (Vieillot).
20. * Larus marinus Linné.
21. * Larus argentatus antelius Iredale.
22. * Larus glaucus Brünnich (=hyperboreus Gunnerus).
23. M. K. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)).
24. * Sterna macrura Naumann.
25. * Arenaria interpres (Linné).
26. * Squatarola helvetica (Linné) (=squatarola (Linné)).
27. * Charadrius pluvialis Linné (=apricarius Linné).
28. * Eudromias (=Charadrius) morinellus (Linné).
29. * Aegialitis (=Charadrius) hiaticula tundrae Lowe.
30. err. Limosa lapponica lapponica (Linné). (Seebohm, 1876, *sub* L. aegocephala (Linné).)
31. * Pavoncella (=Philomachus) pugnax (Linné).
32. trsv.? Calidris arenaria (Linné) (=Crocethia alba (Pallas)).
33. * Limonites (=Calidris) minuta minuta (Leisler).
34. * Limonites (=Calidris) temminckii (Leisler).
35. trsv. Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)).
36. * Pelidna (=Calidris) alpina alpina (Linné).
37. \+ Gallinago (=Capella) gallinago gallinago (Linné).
38. * Phalaropus hyperboreus (Linné) (=lobatus (Linné)).
39. * Lagopus lagopus (Linné), subsp.?
40. err. Lagopus mutus Montin, subsp.? (Dmitrijewa-Sulima, 1909.)
41. * Hierofalco (=Falco) islandus (Brünnich).
42. * Falco peregrinus griseiventris Brehm.
43. \+ Aesalon (=Falco) aesalon (Tunstall).
44. \+ Haliaëtus (=Haliaecëtus) albicilla (Linné).
45. \+ Cygnus cygnus cygnus (Linné).

[1] I cannot make a comparison of my list with Professor Palmén's, since he included birds from the Kanin peninsula as well as those of the lower course of the Pechora.

46. * Cygnus bewickii bewickii Yarrell.
47. * Melanonyx segetum segetum (Gmelin) (=Anser fabalis (Latham)).
48. + Marecca (=Anas) penelope (Linné).
49. + Dafila (=Anas) acuta (Linné).
50. + Fuligula (=Nyroca) marila marila (Linné).
51. * Harelda (=Clangula) glacialis (Linné).
52. + Oidemia fusca fusca (Linné).
53. + Oidemia nigra nigra (Linné).
54. + Erionetta (=Somateria) spectabilis (Linné).
55. * Urinator (=Gavia) stellatus (Pontoppidan).
56. * Urinator (=Gavia) arcticus arcticus (Linné).

From this list it appears that of a total of 56 species known for the regions at the mouth of the Pechora, 51 (or 91.07 per cent) have been found breeding, while 5 species (8.93 per cent) are migrants or found at sea or as accidental visitors.

Section VII. Vaigach Island.

Vaigach Island lies between Jugor Strait on the south and the Kara Gates on the north and extends from Cape Grebeni (69° 39′ north latitude) to Cape Bolvanskij Nos (70° 30′ north latitude), and from Cape Michailow (58° 26′ east longitude) to Cape Koninoi Nos (in Jugor Strait, in longitude 60° 35′ east). In a north-and-south direction it is nearly 110 kilometers long with a breadth from east to west of 43 kilometers. The entire island is included within the lower section (*α salicum*) of the alpine zone and the summits of the elevations alone are bare of vegetation.

Literature.

See **Schalow, H.** Fauna der Arktis (1905).

1. 1908. **Buturlin, S.** [Once more on the Grouse of Nova Zembla.] Our Hunting, no. 8, p. 49–64 (in Russian).
   Buturlin does not admit the presence of a species of Grouse on Vaigach.
2. 1908. **Nossilow, C.** [Last reply to Mr. Buturlin [on the Grouse of Nova Zembla].] Our Hunting, no. 10, p. 87–91 (in Russian).
   Nossilow insists that there is also a Grouse on Vaigach Island, though perhaps it is rare there.
3. 1908. **Molchanow, L. A.** [Ornithological investigations, made in summer 1907 in the Archangel government, on the mainland and on Nova Zembla.] Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 303–314 (in Russian).

List of Birds of Vaigach Island.[1]

?1. + Aegiothus (=Acanthis) sp. et subsp.?
2. * Plectrophenax nivalis nivalis (Linné). (Russian Polar Expedition, Walter *in litt.*)
3. * Calcarius lapponicus lapponicus (Linné).
4. * Otocorys (=Eremophila) alpestris flava (Gmelin).
5. + Anthus cervinus (Pallas). (Russian Polar Expedition—Birula, 1907.)

[1] Species not listed by Schalow are printed in bold-face type.

6. + Saxicola (=Oenanthe) oenanthe oenanthe (Linné).
7. + Nyctea nyctea (Linné).
8. * Cepphus mandti (Lichtenstein).
9. + Stercorarius pomarinus (Temminck).
10. * Stercorarius crepidatus Banks (=parasiticus Linné).
11. * Stercorarius longicaudus (Vieillot).
12. * Larus marinus Linné.
13. * Larus argentatus antelius Iredale. (Pearson, 1898; Buturlin in Dresser, Eggs Birds Europe, 1910.)
14. * Larus glaucus Brünnich (=hyperboreus Gunnerus).
15. * Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)).
16. litt. hib. Pagophila eburnea (Phipps).
17. * Sterna macrura Naumann.
18. + Arenaria interpres (Linné).
19. * Charadrius pluvialis Linné (=apricarius Linné).
20. * Eudromias (=Charadrius) morinellus (Linné).
21. * Aegialitis (=Charadrius) hiaticula tundrae Lowe.
22. * Pavoncella (=Philomachus) pugnax (Linné). (Russian Polar Expedition, Walter, Birula, *ll. cc.*)
23. trsv.? Calidris arenaria (Linné) (=Crocethia alba (Pallas)).
24. * Limonites (=Calidris) minuta minuta (Leisler). (Russian Polar Expedition, Walter, Birula, *ll. cc.*)
25. * Limonites (=Calidris) temminckii (Leisler).
26. * Arquatella (=Calidris) maritima maritima (Gmelin).
27. * Pelidna (=Calidris) alpina alpina (Linné).
28. * Phalaropus hyperboreus (Linné) (=lobatus (Linné)).
29. nid.? Crymophilus fulicarius (Linné)

?30. ? **Lagopus lagopus** (Linné) subsp.? } Nossilow, 1908.
?31. ? **Lagopus mutus** Montin subsp.? }

32. + **Hierofalco** (=**Falco**) sp. (Gillett, 1870.)
33. * Falco peregrinus griseiventris Brehm.
34. + Aesalon (=Falco) aesalon (Tunstall).
35. + Haliaëtus (=Haliaëtus) albicilla (Linné).
36. * Archibuteo (=Buteo) lagopus lagopus (Brünnich).
37. * Cygnus bewickii bewickii Yarrell.
38. + Melanonyx segetum segetum (Gmelin) (=Anser fabalis (Latham)).
39. * Branta berniela berniela (Linné).
40. + Mareca (=Anas) penelope (Linné).
41. + Dafila (=Anas) acuta (Linné).
42. * Harelda (=Clangula) glacialis (Linné).
43. + Oidemia fusca fusca (Linné).
44. * Oidemia nigra nigra (Linné).
45. * Somateria mollissima mollissima (Linné).
46. * Erionetta (=Somateria) spectabilis (Linné).
47. + Merganser (=Mergus) merganser merganser (Linné).
48. + Merganser (=Mergus) serrator (Linné).
49. * Urinator (=Gavia) stellatus (Pontopiddan).
50. * Urinator (=Gavia) arcticus arcticus (Linné).
51. * Urinator (=Gavia) adamsi (Gray).

From this tabulation it appears: (1) of the total number of 51 species listed for Vaigach Island, the manner of occurrence of the two species of Ptarmigan is not wholly clear while for two others, *Aegiothus* (=*Acanthis*) and *Hierofalco* (=*Falco*), the particular race is not certainly identified. Furthermore I prefer to eliminate from the fauna of Vaigach Island the name of *Larus fuscus fuscus* Linné, listed with reservation by Schalow and probably confused by several observers with *Larus argentatus antelius* Iredale. In the recent lists of Trevor-Battye, Pearson, and Buturlin *Larus fuscus fuscus* Linné does not appear; however, one cannot deny the possibility that some straggler might occur, in view of the fact that it has been found even at the mouth of the Yenisei. (2) Forty-nine species (or 96.08 per cent) nest or may do so in Vaigach Island and two species (or 3.92 per cent) do not breed there but have been found either in the migration period or wintering.

Section VIII. Nova Zembla.

The double island of Nova Zembla extends from latitude 70° 30′ to 77° north, between longitudes 51° 30′ and 69° east of Greenwich. In a north-and-south direction the two islands have a total length of nearly 1070 kilometers, with a breadth of about 140 kilometers. This double island lies altogether within the alpine zone. Its southern portions are included within the lower section (*Regio alpina α salicum*), the more elevated parts as well as the regions farthest to the north, belong to the median section (*Regio alpina β camporum nudorum*), while the most northerly areas of the north island (Lütke Land) are covered with snow and ice and belong to the uppermost section (*Regio alpina γ glacialis*). The coasts of both islands are precipitous and high, and form on the western side a long series of *bazary* or "gull rocks" which in the south island are chiefly inhabited by *Uria lomvia lomvia* (Linné) and *Rissa rissa rissa* (Linné) (=*tridactyla tridactyla* (Linné)), while on the north island such cliffs form the breeding places of *Fulmarus glacialis glacialis* (Linné) and *Mergulus* (=*Alle*) *alle* (Linné). The eastern coasts have been very little investigated and we have at hand but few data as to these parts of the double island. It remains for me to draw the reader's attention to the fact that the avifauna of Nova Zembla, thanks no doubt to the influence of a branch of the Gulf Stream that flows along the western shores, includes the rather large number of 19 accidental visitors of which four belong to circumpolar species, ten to northern Atlanto-European species, one to a boreal Europeo-Siberian species, and two to nearctic species.

Literature.

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2. 1789. **Krestinin.** [First appendix to the geographical news on the New Land of the North.] New monthly memoirs, no. 31, p. 35 (in Russian).
   Unimportant ornithological notes.
3. 1805. **Lepechin, Jwan.** [Voyages.] Pt. 4, 1772. St. Pétersbourg, 4to (in Russian).
   Birds, p. 138–139, 173.
4. 1824. **Lütke I., Capit.-Lieut.** [On the expeditions to Nova Zembla.] Memoirs, edited by the Naval Department, concerning navigation, sciences and literature, vol. 7, p. 1–75 (in Russian).
   Birds, p. 74.
5. 1842. **Anon.** [The expedition of Lieutenant Pachtussow to Nova Zembla in 1832 and 1833.] Mem. of the Dept. of Hydrogr., vol. 1, p. 1–224 (in Russian).
   Notes on birds, pp. 111, 112, 130, 168, 176, 216, 217.
6. 1842. **Pachtussow, Lieutenant.** [Diary conducted during the hydrographic survey of the east coast of Nova Zembla in 1834 and 1835.] Mem. of the Dept. of Hydrogr., vols. 1 2 (in Russian).
   Birds, p. 216–217.
7. 1844. **Pachtussow, Lieutenant.** [Diary conducted during the hydrographic survey of the east coast of Nova Zembla in 1832 and 1833.] Mem. of the Dept. of Hydrogr., vols. 1, 2 (in Russian).
   Birds: pp. 26, 63, 75, 78–80, 82–83, 85, 90, 112, 118–119, 122, 151–152, 216–217, 218–219; vol. 2, pp. 53, 65, 69, 96.
8. 1845. **Anon.** Nowaja Semlja. [Translation of the article published in Russian in the journal, Severnaja Pchela, of 30 May.]
   A few unimportant notes on birds.
9. 1845. **Moisejeff, Ensign.** [Diary conducted during the hydrographic survey of Nova Zembla, in 1838 and 1839.] Mem. of the Dept. of Hydrogr., vol. 3 (in Russian).
   Birds: p. 57–60, 72–75, 90, 91–92, 108. The notes on birds are quite unimportant.
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    Unimportant notes on birds.
11. 1846. **Anon.** [Nova Zembla.] Mem. of the Dept. of Hydrogr., vol. 3, pp. 65, 90 (in Russian).
12. 1847. **Boguslav, Jos.** [Nova Zembla and its fishing and hunting.] Mem. of the Free Econ. Soc., 1847, no. 2, p. 375–396 (in Russian).
13. 1848. **Wereschagin, W.** [Nova Zembla.] The Star, vol. 27, p. 129–130, 135 (in Russian).
    Extract from journal of Moisejeff.
14. 1862. **Sarinskij, M.** [Nova Zembla.] Almanac of Govt. of Archangel, 1862, p. 155 (in Russian).
    Unimportant list of birds.
15. 1866. **Svenske, Ch.** [Nova Zembla from the points of view of geography, natural history, fishing and hunting.] St. Pétersbourg, 4to (in Russian).
    Birds, p. 103–109, 128–129.
16. 1868. **Anon.** Novaja Semlja. "Die Libelle," Riga, no. 25, p. 196.
    A few unimportant notes on birds.
17. 1871. **Anon.** [Nova Zembla.] The Family Evenings, pt. 6, p. 104–105 (in Russian).
    Unimportant list of birds.
18. 1873. **Heuglin, Th. von.** Mittheilung. Ber. 20 Ver. Deutsch. Ornith. Ges. zu Cassel, p. 66.
19. 1873. **Sidorow, M.** [Wintering in Nova Zembla.] Bull. Russian Geogr. Soc., vol. 9, p. 162–186 (in Russian).
20. 1874. **Pelzeln, A. von.** Ueber die wichtigeren Acquisitionen des K. K. Zoölogischen Cabinets in den Abtheilungen der Säugethiere und Vögel während des Jahres 1873. Sitzb. zoöl.-bot. Ges. Wien, vol. 24, p. 170.
    Falco peregrinus brought back by Count Wilžek from Nova Zembla.

21. 1879. **Toeppen, Hugo.** Die Doppelinsel Nowaja Semlja. Geschichte ihrer Entdeckung. Mit einer ausführlichen Karte. Leipzig, 8vo.
Birds, p. 110–111; compilation, with doubtful notes on a bird of prey (*Falco buteo?*); mention of Grouse (*Tetrao lagopus*), *Cygnus musicus*, *Uria grylle*.
22. 1879. **Goebel, H., Forstmeister.** Reisebriefe. St. Petersburger Herold, Feuilleton-Beiblatt, no. 43, 25 Oct. 1879; no. 44, 1 Nov. 1879.
Birds of Nova Zembla. The first numbers of the series of *feuilletons* cited bear the title, Auf dem Wege nach der Halbinsel Kanin, which Goebel intended to visit. Arrived at Archangel, he learned that the Russian naval transport "Bakan" was to leave the following day for Nova Zembla, so taking advantage of this fortunate circumstance he spent a week in Nova Zembla in the course of which he discovered the presence of a large Diver which he identified as *Colymbus glacialis*, of the Ptarmigan and the occurrence of a Swallow (*Hirundo rustica*), caught in the house of the life-saving station at Malijy Karmakuly.
23. 1881. **[Ochochinski, P.]** [Nova Zembla and Kolguev.] Illustrated Russia, vol. 1, p. 228 (in Russian).
24. 1883. **Fridolin (stud. pharm.)** [*Uria brünnichii* von Nowaja Semlja.] Sitzungsb. Dorpat. Nat. Ges., vol. 6, p. 418.
25. 1883. **Uchtomski, Pr. L.** [Nova Zembla. An ethnographical study.] 8vo, p. 1–109 (in Russian). Birds, pp. 15, 30, 32.
26. 1884. **Solovjeff, A.** [Some information concerning Nova Zembla.] Nature and Hunting, 1884, no. 5, p. 74–79 (in Russian). The bird notes are unimportant.
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30. 1894. **Nossilow, C.** Voyage à la Nouvelle-Zemble. Tour du Monde, 1894, p. 81–96.
Ornithology, p. 94.
31. 1897. **Pearson, H. J., and Feilden, Col.** [Brief account of their expedition to Nova Zembla during the summer.] Bull. Brit. Ornith. Club, vol. 7, p. ii.
32. 1899. **Pearson, H. J.** [Exhibition of a female of the Gray Phalarope (*Crymophilus fulicarius*) procured by W. S. Bruce in Nova Zembla.] Bull. Brit. Ornith. Club, vol. 8, p. xxx.
33. 1899. **Ostrovski, D.** [Guide-book to Northern Russia.] (Archangel, White Sea, Solovetzki monastery, Murman coast, Nova Zembla, Pechora). 2d ed., St. Pétersbourg, 8vo (in Russian).
Birds, pp. 105, 119. The notes on birds of Nova Zembla, borrowed from doubtful sources, are of no scientific value.
34. 1900. **M. M.** [At Nova Zembla.] Journ. of Nat. Hist. and Geogr., vol. 8, p. 62–73 (in Russian).
35. 1902–03. **Smirnow, N.** [Ornithological observations made in the southeast part of the Barenz Sea.] Nature and Hunting, 1902, no. 10, p. 1–3; no. 11, p. 19–21; no. 12, p. 58–60; 1903, no. 3, p. 18–21; no. 5, p. 19–22; no. 6, p. 14–17; no. 7, p. 23–25 (in Russian).
36. 1903. **Smirnow, N.** [Ornithological observations made in Nova Zembla and on Kolguev Island.] Nature and Hunting, 1903, no. 8, p. 46–48 (in Russian).
37. 1904. **Bilkiewicz, S.** [Materials on mammals and birds of Nova Zembla.] Appendix Memoirs Exped. Univ. Kasan, Kasan, 4to (in Russian). Birds, p. 13–30.
38. 1906. **Buturlin, S.** [The Snipes of the Russian Empire.] Part 2. Moscow, 8vo (in Russian).
39. 1907. **Buturlin, S.** [Interesting finds.] Venery and Hunting, St. Pétersbourg, p. 99 (in Russian).
40. 1907. **Buturlin, S.** On Bean Geese. Journ. Bombay Soc. Nat. Hist., vol. 17, p. 603–607.

41. 1907. **Pearson, H. J.** On *Lagopus hyperboreus* recorded from Alger Island, Franz Joseph Land. Bull. Brit. Ornith. Club, vol. 19, p. 77; with note by Ogilvie-Grant on the occurrence of Ptarmigan on Nova Zembla.

42. 1907. **A Samoyede [Bykow, A.]** [Nova Zembla. An essay.] Our Hunting, 1907, no. 9, p. 56–59; no. 10–12, p. 185–197 (in Russian).

Birds, p. 187; of no value, since the ornithological data are taken from Ostrovski's Guide to Northern Russia.

43. 1908. **Buturlin, S.** [As to the memoir on Nova Zembla.] Our Hunting, 1908, no. 2, p. 122–123 (in Russian).

Buturlin denies that there is a Grouse or Ptarmigan on Nova Zembla.

44. 1908. **Bykow, A.** (**A Samoyede.**) [A post-card on the address of S. Buturlin.] Our Hunting, no. 5, p. 77 (in Russian).

Cites the Guide for the North of Russia, published by D. Ostrovski as source from which he borrowed the notes on Grouse or Ptarmigan in Nova Zembla.

45. 1908. **Nossilow, C.** [Does the Grouse inhabit Nova Zembla?] Our Hunting, 1908, no. 6, p. 62–63 (in Russian).

Nossilow states that the Grouse is found in the southern part of Nova Zembla, in the vicinity of Sochaniha River.

46. 1908. **Buturlin, S.** [On the question of the Grouse of Nova Zembla.] Our Hunting, 1908, no. 6, p. 64–68 (in Russian).

Criticism of Nossilow's paper and affirmation of his doubts as to the existence of Grouse or Ptarmigan on Nova Zembla.

47. 1908. **Nossilow, C.** [Reply to Mr. Buturlin.] Our Hunting, 1908, no. 8, p. 44–48 (in Russian).

Nossilow quotes from his journal as to the finding of Ptarmigan in Nova Zembla.

48. 1908. **Buturlin, S.** [Once more on the Grouse of Nova Zembla.] Our Hunting, 1908, no. 8, p. 49–64 (in Russian).

Buturlin admits that the Ptarmigan may occur in the southwest part of the south island but not in Nova Zembla proper, in Lütke Land or Vaigach Island.

49. 1908. **Nossilow, C.** [Last reply to Mr. Buturlin. (On the Grouse of Nova Zembla)]. Our Hunting, 1908, no. 10, p. 87–91 (in Russian).

Nossilow insists that there is a Grouse on Vaigach also, though it is perhaps rare there.

50. 1908. **Buturlin, S.** [Once more on the Grouse of Nova Zembla.] Our Hunting, 1908, no. 10, p. 92–97 (in Russian).

Buturlin reiterates that the Grouse or Ptarmigan has not been found by naturalists in the greater part of the archipelago, and admits with reservations, the possibility that it may occur in the southeastern part of Nova Zembla.

51. 1908. **Buturlin, S.** [Bean Geese.] Our Hunting, 1908, no. 11, p. 21–28 (in Russian).

52. 1908. **Molchanow, L. A.** [Ornithological investigations, made in summer of 1907 in the government of Archangel, on the mainland, and in Nova Zembla.] Annuaire Mus. Zool. St. Pétersbourg, vol. 13, p. 303–314 (in Russian).

53. 1909. **Dmitrijewa-Sulima, M.** [On the beaver, the Grouse and the Woodcock.] Our Hunting, 1909, no. 11, p. 91–93 (in Russian).

54. 1909. **Bykow, A.** [New investigations upon an old question.] Our Hunting, 1909, no. 11, p. 93–95 (in Russian).

The question as to the Grouse of Nova Zembla.

55. 1909. **Buturlin, S.** [As to the observations on the Grouse.] Our Hunting, 1909, no. 12, p. 117–120 (in Russian).

56. 1909. **Duc d'Orléans.** La Revanche de la Banquise. Un été de dérive dans la mer de Kara, juin-septembre, 1907. Paris, 4to.

57. 1910. **Schidlovski, A.** [Bibliographical index to the literature upon the North based on the materials, collected by the Archangel Society for Study of the North of Russia. Nova Zembla. Index of the special memoirs, of the papers and notes of men of science, travellers and Russian writers.] Appendix to the Materials for our Knowledge of Nova Zembla, pt. 1, p. 1–63 (in Russian).

58. 1910–11. **Sosnovski, T.** [Materials for our knowledge of Nova Zembla.] Edition of the Chief Board of Agriculture. Part 1, with 33 autotypes and 4 maps, 1910; Part 2, with 74 autotypes and 4 maps, 1911. St. Pétersbourg, 8vo (in Russian).
Ornithological notes: Part 1, pp. 38, 108; Part 2, pp. 17, 19, 24, 27, 28, 79, 153.

59. 1911. **Russanow, B.** [On board of the "Dmitri Solunski" around Nova Zembla. Narrative of the voyage of the expedition to Nova Zembla in 1910.] Materials for our Knowledge of Nova Zembla, pt. 2, p. 1–71 (in Russian).

60. 1911. **Molchanow, L. A.** [Some words upon the birds of the north island of Nova Zembla.] Mess. Ornith., vol. 2, p. 109–111 (in Russian).
Notes made by Russanow from 1907 to 1910.

61. 1916. **Schaanning, H. T. L.** Bidrag til Novaja Semljas Fauna. Danske Ornithologisk Forenings Tidskrift, vol. 10, p. 145–190.

62. 1917. **Haase, O.** Beiträge zur Avifauna. Nach dem Dänischen von H. Theo L. Schaanning. Journ. f. Ornith., vol. 65, extra no. 2, p. 63–72.

63. 1917. **Schalow, H.** Einige Bemerkungen über die Vogelfauna von Novaja Semlja. Journ. f. Ornith., vol. 65, extra no. 2, p. 215–222.

64. 1924. **Schaanning, H. T. L.** Die Vögel. Rept. of Sci. Results Norwegian Exped. to Novaja Zemlja 1921. N. 11, Kristiania.

65. 1925. **Gorbunow, G.** [The gull-rocks (*Bazary*) of Nova Zembla.] Mem. Sci. Inst. for Exploration of the North, pt. 26 (in Russian).

66. 1925. **Jordans, A. von.** Beitrag zur Kenntniss der Vogelwelt Nowaja Semljas. Journ. f. Ornith., vol. 73, p. 446–452.

67. 1926. **Gorbunow, G.** [List of the birds of Nova Zembla, observed during the expeditions under Samilowicz and Derjugin.] (MS., in Russian.)

The list of birds of Nova Zembla published by Schalow in 1917, includes but 53 species. Because I prefer to unite *Branta bernicla bernicla* and *Branta bernicla glaucogastra* Brehm I am thus able to add 21 species but those in my list numbered 43 and 44, are included with interrogation marks for reasons explained in the body of the text under the several species, and their presence requires confirmation from future observations.

All the 74 species have been recorded for the southern island, but for the northern island we know but 32. Of the total number recognized from Nova Zembla, on the south island 49 species (or 66.2 per cent) breed, while the remaining 25 species (or 33.8 per cent) have been noted either as of accidental occurrence, as migrants or as winter residents. On the north island 30 species (or 93.75 per cent) breed and 2 (or 6.25 per cent) are of casual occurrence.

Section IX. The Franz Josef Archipelago.

The Franz Josef archipelago, situated approximately between latitude 80° and 82° 15′ north and between longitude 39° and 63° east, consists of a rather considerable number

List of Birds of Nova Zembla.[1]

	South Island (Sec. VIII, a)	North Island (Sec. VIII, b)
1. **Corvus corax corax** Linné	orr. (Krivoscheja, 1884)	
2. **Corone** (=**Corvus**) **cornix cornix** (Linné)	orr. (Zitkow and Buturlin, 1901)	
3. **Trypanocorax** (=**Corvus**) **frugilegus frugilegus** (Linné)	orr. (Tolmacheff, 1924)	
4. **Aegiothus** (=**Acanthis**) **hornemanni exilipes** (Coues)	orr. (Gorbunow took a young bird of two near Matochkinshar, 1924)	
5. **Passer domesticus domesticus** (Linné)	orr. (Zitkow and Buturlin, 1901)	
6. **Plectrophenax nivalis nivalis** (Linné)	*	* (to 76° north[2])
7. **Calcarius lapponicus lapponicus** (Linné)	*	
8. **Otocorys** (=**Eremophila**) **alpestris flava** (Gmelin)	*	*
9. **Anthus cervinus** (Pallas)	*	
10. **Saxicola** (=**Oenanthe**) **oenanthe oenanthe** (Linné)	+(taken in 1924 by Tolmacheff.)	
11. **Hirundo rustica rustica** Linné	orr.	orr.
12. **Coracias garrulus** Linné	orr.[3]	
13. **Nyctea nyctea** (Linné)	*(eggs taken by Nossilow and Borissow)	*(seen by Russanow to 74° N., see Molchanow, 1911)
14. **Alca torda** (Linné)	orr. (According to Gorbunow 1925, 1926, killed at Malijy Karmakuly	
15. **Fratercula arctica** (Linné)		*[4]
16. **Uria troille troille** (Linné) and variant **lacrymans** (Valenciennes)	+(found 1924 by C. Derjugin)	
17. **Uria lomvia lomvia** (Linné)	*	*[5]
18. **Cepphus mandti** (Lichtenstein)	*	*
19. **Mergulus** (=**Alle**) **alle** (Linné)	bib.[6]	*[7]
20. **Megalestris catarrhactes** (Linné) (=**Stercorarius skua** (Brünnich))	orr. (Smirnow, 1901)	
21. **Stercorarius pomarinus** (Temminck)	+	+
22. **Stercorarius crepidatus** Banks (=**parasiticus** (Linné))	*	*(seen by Russanow to 75° N., see Molchanow, 1911)
23. **Stercorarius longicaudus** (Vieillot)	+	+
24. **Larus argentatus antelius** Iredale	+(Molchanow, 1908; Gorbunow, 1926)	
25. **Larus glaucus** Brünnich (=**hyperboreus** Gunnerus)	*	*[8]
26. **Larus leucopterus** Faber (=**glaucoides** Meyer)	orr.[9]	

[1] Species not listed in Schalow's work (Journ. f. Ornith., vol. 65, extra no. 2, p. 215–222, 1917) are printed in bold-face type.

[2] Feilden, in Markham, A Polar Recon., etc., 1881, p. 333; Molchanow, *fide* Russanow, 1911.

[3] Received frozen by Schaanning from a Samoyede, on 30 March 1903, on the south island (Journ. f. Ornith., vol. 65, extra no. 2, p. 70, 1917; Schaanning, 1917; Haase, 1917).

[4] Its breeding places are north of Nordenskjold Bay, in latitude 75° 5′ north (Russanow, see Molchanow, 1911).

[5] Russanow (see Molchanow, 1911) says its breeding grounds extend to latitude 76° north.

[6] Bilkiewicz (1904) believes the Little Auk occurs only in winter in the latitude of the south island and does not breed there. I therefore list it as wintering on the coasts of the south island and as breeding on the coasts of the north island.

[7] According to Russanow (Molchanow, 1911) there are many breeding places in 76° north latitude.

[8] Seen by Russanow to 76° north latitude (see Molchanow, 1911) and by Feilden to 78° 7′ north (see Markham, 1881).

[9] Specimen sent by Nossilow to our Zoological Museum.

List of Birds of Nova Zembla—Continued.

	South Island (Sec. VIII, a)	North Island (Sec. VIII, b)
27. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné))	*	*
28. Pagophila eburnea (Phipps)	*	*
29. Sterna macrura Naumann	*	*
30. Arenaria interpres (Linné)	*	*
31. Squatarola helvetica (Linné) (=squatarola (Linné))	err. (?Jordans, 1925)	.....
32. **Charadrius pluvialis** (Linné) (=**apricarius** Linné)	err.[10]	.....
33. Eudromias (=Charadrius) morinellus (Linné)	*[11]	*
34. Aegialitis (=Charadrius) hiaticula tundrae (Lowe)	*	+[12]
35. Calidris arenaria (Linné) (=Crocethia alba (Pallas))	err.? +?[13 14]	err.?[14]
36. Limonites (=Calidris) minuta minuta (Leisler)	*	.....
37. Arquatella (=Calidris) maritima maritima (Gmelin)	*	*
38. Pelidna (=Calidris) alpina alpina (Linné)	+	.....
39. **Totanus fuscus** (Linné) (=**Tringa erythropus** Pallas)	err. (Jordans, 1925)	.....
40. Phalaropus hyperboreus (Linné) (=lobatus (Linné))	*	.....
41. Crymophilus fulicarius (Linné)	*	.....
42. **Grus** (=**Megalornis**) **cinerea** subsp.?	err. (Molchanow, 1911)	.....
?43. **Lagopus lagopus** (Linné), subsp.?	?	?
44. **Lagopus mutus** Montin, subsp.? an **Lagopus hyperboreus** Sundevall?	?[15]	?
45. Hierofalco (=Falco) sp.?	+	.....
46. Falco peregrinus griseiventris Brehm	*	*
47. Aesalon (=Falco) aesalon (Tunstall)	+[16]	.....
48. Haliaëtus (=Haliaecetus) albicilla (Linné)	+	.....
49. **Cygnus cygnus cygnus** (Linné)	err.[17]	.....
50. Cygnus bewickii bewickii Yarrell	*	.....
51. Melanonyx (=Anser) neglectus (Sushkin)	*[18]	?*
52. Melanonyx arvensis arvensis (Brehm) (=Anser fabalis (Latham))	*[19]	*[20]
53. Melanonyx segetum segetum (Gmelin) (=Anser fabalis (Latham))	+	?
54. Anser albifrons (Scopoli)	*	*
55. Anser erythropus Linné	err.[21]	.....

[10] See Feilden in Markham, 1881.

[11] Bilkiewicz, 1904.

[12] Small numbers noted by Russanow to 75° 5′ north latitude (see Molchanow, 1911).

[13] Buturlin, 1906, p. 245, and Our Hunting, 1908, no. 8, p. 49–64; Schaanning, 1907.

[14] Gorbunow, 1926, observed the Sanderling in Puchowaja Bay, on Cape Dmitrijeff, on Belushja (Dauphin) Bay, of the south island and in Krasheninnikow Bay on the north island.

[15] See Krivosheja, 1884; Nossilow, 1908; observation of Goebel published by Smirnow, 1903; Jordans, 1925.

[16] See von Heughn; Grigorjeff; Nossilow; Molchanow, 1908; Schaanning, 1907.

[17] See Uchtomski, 1883; observation of Goebel; Smirnow, 1903; Jordans, 1925; Gorbunow, 1926.

[18] See Nossilow, 1894; Buturlin, 1908, no. 51; Schaanning, 1907.

[19] See Buturlin, 1908, no. 51.

[20] Seen by Russanow to 76° north, *fide* Molchanow, 1911.

[21] Specimen in our Zoöl. Mus. collected by Prof. A. Grigorjeff; Nossilow, 1899.

List of Birds of Nova Zembla—Continued.

	South Island (Sec. VIII, a)	North Island (Sec. VIII, b)
56. **Branta leucopsis** (Bechstein)	+(Bilkiewicz, 1904; Jordans, 1925)	
57. Branta bernicla bernicla (Linné)	trsv.	*
58. **Rufibrenta** (=**Branta**) **ruficollis** (Pallas)	err. (Smirnow, 1901)	
59. Mareca (=Anas) penelope (Linné)	err.	
60. **Nettion** (=**Anas**) **crecca** (Linné)	err. (Gorbunow, 1926)	
61. Harelda (=Clangula) glacialis (Linné)	*	*
62. Oidemia fusca fusca (Linné)	+	
63. Oidemia nigra nigra (Linné)	+	
64. **Heniconetta** (=**Polysticta**) **stelleri** (Pallas)	err. (Bilkiewicz, 1904)	
65. Somateria mollissima mollissima (Linné)	*	*
66. Erionetta (=Somateria) spectabilis (Linné)	*	*
67. Merganser (=Mergus) merganser merganser (Linné)	+	
68. Merganser (=Mergus) serrator (Linné)	*	+
69. **Mergus albellus** Linné	err. (Smirnow, 1901)	
70. Fulmarus glacialis glacialis (Linné)	*	*
71. Urinator (=Gavia) stellatus (Pontoppidan)	*	*
72. Urinator (=Gavia) arcticus arcticus (Linné)	*	*
73. **Urinator** (=**Gavia**) **immer** (Brünnich)	err. (Molchanow, 1908)	
74. Urinator (=Gavia) adamsi (Gray)	*	

of large and small islands, extending from Alexandra Land in a southwest-northeast direction as far as the islands Hvidtenland and Liv Island, discovered by Nansen. Most of these land areas are covered with ice, and come in the uppermost section of the alpine zone, but there are also parts that are free from snow and even support a dwarfed vegetation. These should be regarded as pertaining to the middle and lower sections of the same zone. The presence of a certain amount of vegetation explains the relatively recent discovery of the Spitzbergen Ptarmigan (*Lagopus hyperboreus* Sundevall) on some of the islands of the archipelago (Alger Island, Hooker Island). Along the arctic seacoasts there are in many places populous colonies of different Guillemots, Gulls and Fulmars.

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(Unimportant ornithological notes on pp. 131, 133.)

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6. 1901. **Salvadori, T.** Spedizione polari di S. A. R. Luigi di Savoia Duca degli Abruzzi. Cenni preventivi sulla raccolte ornithologiche. Bol. Mus. Torino, vol. 16, no. 391.
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List of Birds of Franz Josef Land.[1]

1.	*	Plectrophenax nivalis nivalis (Linné).
2.	err.	Calcarius lapponicus lapponicus (Linné).
3.	err.	Otocorys (=Eremophila) alpestris flava (Gmelin).
4.	err.	**Hirundo rustica rustica** Linné. (Jackson, 1899.)
5.	+	Nyctea nyctea (Linné).
?6.	*	Fratercula arctica arctica (Linné).
7.	*	Uria lomvia lomvia (Linné).
8.	*	Cepphus mandti (Lichtenstein).
9.	*	Mergulus (=Alle) alle (Linné).
10.	err.	Stercorarius pomarinus (Temminck). (Duke of Abruzzi's expedition, see Salvadori, 1901.)
11.	*	Stercorarius crepidatus Banks (=parasiticus Linné).
12.	err.	Stercorarius longicaudus (Vieillot). (Duke of Abruzzi's expedition, see Salvadori, 1901.)
?13.	err.	Larus marinus Linné.
14.	*	Larus glaucus Brünnich (=hyperboreus Gunnerus).
15.	*	Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)).
16.	*	Pagophila eburnea (Phipps).
17.	hib.	Rhodostethia rosea (Macgillivray).
18.	+	Sterna macrura Naumann.
19.	err.	Arenaria interpres (Linné).
20.	err.?	an +? Calidris arenaria (Linné) (=Crocethia alba (Pallas)).
21.	err.	Heteropygia (=Calidris) fuscicollis (Vieillot).
22.	*	Arquatella (=Calidris) maritima maritima (Gmelin).
23.	*	Crymophilus fulicarius (Linné).
24.	*	**Lagopus hyperboreus** Sundevall. (Ziegler Expedition, Fiala; Pearson, Miller, *ll. cc.*, 1907; observation of Wiese, Sedow Expedition.)

[1] Species not listed by Schalow are printed in bold-face type.

25. err. Hierofalco sp.? (Hierofalco (=Falco) candicans (Gmelin) –*teste* Neale, Proc. Zool. Soc. London, 1882, p. 653).
26. err. **Melanonyx** (=Anser) **brachyrhynchus** (Baillon). (Sedow Expedition, Bianchi, 1917—sub *M. segetum segetum*).
27. * Branta bernicla bernicla (Linné).
28. * Somateria mollissima mollissima (Linné).
29. \+ Erionetta (=Somateria) spectabilis (Linné).
30. * Fulmarus glacialis glacialis (Linné).
31. \+ Urinator (=Gavia) stellatus (Pontoppidan).

Schalow's list (*l.c.*, p. 275) of the birds of the Franz Josef archipelago enumerates 28 species. To this number I am able to add three. Species numbered 6 and 13 require further confirmation. Of the total number of 31 species known from the archipelago, 19 (or 61.29 per cent) have been found breeding there, and 12 (or 38.71 per cent) do not breed (eleven are accidental and one is a winter visitor).

Section X. Coasts of the Kara Sea, Yamal Peninsula and Mouth of the Ob.

The section of the Kara Sea region extends from the entrance of Jugor Strait on the west (Chabarova, in latitude 69° 39′ north and about longitude 60° east) to the western coast of the Yenisei delta (Mattesala promontory, in approximately 73° north and 76° 30′ east). It embraces the Kara Sea, where several arctic species of Guillemots and Gulls winter, the coasts surrounding Baidaratskaja Bay and the western shores of the Yamal peninsula. Included in this area on the mainland is the range of Paë-choi Mountains, which are the most northerly extension of the Ural. This range has not been investigated ornithologically since Hoffmann's journey, but the recent expedition of the Kusnetzow brothers under the leadership of H. Backlund, with J. Wardropper as naturalist, has furnished us with some very valuable information. This section likewise includes the entire Yamal peninsula, lately explored by Zitkow; it extends northward to Malygin Strait (72° 52′ north latitude) and as far as Bjelyj Island (White Island), situated between latitude 73° and 73° 25′ north. Finally the whole of Ob Bay and the western shore of the Gydanski peninsula as far as the Mattesala promontory likewise form part of this section.

The upper limit of the forest zone reaches the foot of the northern part of the Urals at sea level, beyond 68° north latitude while the mountains themselves belong in part to the subalpine zone and chiefly (especially their tops) to the alpine zone. The Paë-choi range is quite bare of forest and is included within the subalpine and alpine zones. The tree limit extends along the southern coast of Baidaratskaja Bay, cutting the Yamal peninsula nearly on the 68th parallel. On the latter, alder thickets extend (according to Zitkow, 1909, p. 489) as far as Lake Jarro-to and low willows as far north as 70°, these for the most part but one or two feet high though in the Juri-bei valley they attain a

height of four or five feet. North of 70° the bushy growth becomes scarce and the prostrate willows cover only limited areas. The southern parts of the Yamal peninsula as far as 70° north latitude belong therefore, for the most part, to the subalpine zone, and in small degree to the lower section of the alpine region. The portion lying to the north of 70° is included in the alpine zone but in view of the lack of more precise knowledge I cannot undertake to delimit this part more precisely. Along the shores of the Arctic Ocean stretches a sort of rampart from six to thirty meters in height topped by dunes bearing a very scanty vegetation.

Cliffs, such as might afford nesting places for colonies of Guillemots and Gulls, are altogether lacking.

Literature.

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17. 1926. **Serebrowsky, P.** Uebersicht der in Russland vorkommenden Formen von *Lagopus mutus* Montin. Journ. f. Ornith., vol. 74, p. 691–698.

List of Birds of Kara Sea and Yamal Peninsula.[1]

1. err. Corvus corax corax Linné.
2. \+ Aegiothus (=Acanthis) hornemanni exilipes (Coues).
3. ?+ Aegiothus (=Acanthis) linaria linaria (Linné).
4. * Plectrophenax nivalis nivalis (Linné). (Russian Polar Expedition, Birula, 1907.)
5. * Calcarius lapponicus lapponicus (Linné).
6. * Otocorys (=Eremophila) alpestris flava (Gmelin).
7. + Motacilla alba alba Linné.
8. + Budytes citreola citreola (Pallas).
9. + Anthus pratensis (Linné).
10. * Anthus cervinus (Pallas). (Russian Polar Expedition, Birula, 1907.)
11. + Phylloscopus trochilus (Linné).
12. + Turdus pilaris Linné.
13. + Saxicola (=Oenanthe) oenanthe oenanthe (Linné).
14. + Cyanecula (=Luscinia) svecica svecica (Linné).
15. * Nyctea nyctea (Linné).
16. + Asio accipitrinus (Pallas) (=flammeus (Pontoppidan)).
17. M. K. **Uria lomvia lomvia** (Linné). (Duc d'Orléans, *l.c.*, 1909, sub *Uria troile* (Linné)).
18. M. K. Cepphus mandti (Lichtenstein). (Duc d'Orléans, 1909, sub *Uria grylle* (Linné); Wardropper-Backlund Exped., Cape Tolsty.)
19. + Stercorarius pomarinus (Temminck). (Russian Polar Expedition, Birula, 1907.)
20. + Stercorarius crepidatus Banks (=parasiticus Linné).
21. + Stercorarius longicaudus (Vieillot).
22. + Larus marinus Linné.
23. * Larus argentatus antelius Iredale. (Russian Polar Expedition, Kara Sea, Birula, 1907, sub *Larus fuscus* (?)).
24. + **Larus argentatus taimyrensis** (Buturlin). (Specimen in our Zoölogical Museum.)
25. * Larus glaucus Brünnich (=hyperboreus Gunnerus). (Russian Polar Exped.—Jugor Strait, Walter, 1901; Birula, 1907.)
26. M. K. Rissa rissa rissa (Linné) (=tridactyla tridactyla Linné). (Collett and Nansen (1899)—Jugor Strait.)
27. M. K. Pagophila eburnea (Phipps).
28. * Sterna macrura Naumann. (Russian Polar Expedition, Birula, 1907.)
29. * Arenaria interpres (Linné).
30. * Squatarola helvetica (Linné) (=squatarola (Linné)).
31. + Charadrius pluvialis Linné (=apricarius Linné). (Zitkow, 1912.)
32. + **Charadrius dominicus fulvus** Gmelin. (Zitkow, 1912.)
33. * Eudromias (=Charadrius) morinellus (Linné).
34. * Aegialitis (=Charadrius) hiaticula tundrae (Lowe).
35. + Pavoncella (=Philomachus) pugnax (Linné). (Russian Polar Expedition, Jugor Strait, Walter, 1901; Birula, 1907.)
36. ? err. **Glottis (=Tringa) nebularius** (Gunnerus). (Collett and Nansen, 1899.)
37. **an* trsv? Calidris arenaria (Linné) (=Crocethia alba (Pallas)).
38. * Limonites (=Calidris) minuta minuta (Leisler). (Russian Polar Expedition, Jugor Strait, Walter, 1901; Birula, 1907.)
39. * Limonites (=Calidris) temminckii (Leisler).
40. *litt. **Arquatella (=Calidris) maritima maritima** (Gmelin). (Zitkow, 1912.)

[1] Species not listed by Professor Palmén are printed in bold-face type.

41. **an* trsv.? Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)).
42. * Pelidna (=Calidris) alpina alpina (Linné).
43. * Phalaropus hyperborcus (Linné) (=lobatus (Linné)).
44. * **Crymophilus fulicarius** (Linné). (Duc d'Orléans, 1909; Zitkow, 1912.)
45. * Lagopus lagopus (Linné), subsp.? *an* Lagopus lagopus koreni Thayer and Bangs?
46. * **Lagopus mutus rupestris** (Gmelin). (Specimen in our Zoölogical Museum; Hoffmann's expedition to Urals; Backlund-Wardropper Expedition; Zitkow, 1912, sub *Lagopus mutus* (Montin).)

?47. + **Hierofalco** (=**Falco**) sp.? (*Hierofalco candicans* (Gmelin)? Backlund, 1911.)
48. * Falco peregrinus griseiventris (Brehm).
49. + Aesalon (=Falco) aesalon (Tunstall).
50. + Haliaëtus (=Haliaeëtus) albicilla (Linné).
51. + Archibuteo (=Buteo) lagopus pallidus Menzbier.
52. * **Cygnus bewickii bewickii** Yarrell. (Zitkow, 1912.)
53. * Melanonyx arvensis arvensis (Brehm) (=Anser fabalis (Latham)).
54. * **Melanonyx segetum segetum** (Gmelin) (=Anser fabalis (Latham)). (Buturlin, Our Hunting, 1908, no. 11, p. 27; Zitkow, 1912.)
55. * Anser albifrons (Scopoli).
56. + Anser erythropus (Linné). (Dresser, Eggs Birds Europe, p. 538, 1910, *fide* Buturlin.)
57. * **Branta bernicla bernicla** (Linné). (Zitkow, 1912.)
58. + Rufibrenta (=Branta) ruficollis (Pallas).
59. + Mareca (=Anas) penelope (Linné).
60. + Nettion (=Anas) crecca (Linné).
61. + Dafila (=Anas) acuta (Linné).
62. + **Fuligula** (=**Nyroca**) **marila marila** (Linné). (Zitkow, 1912.)
63. * Harelda (=Clangula) glacialis (Linné). (Russian Polar Expedition, Jugor Strait, Walter, 1901; Birula, 1907.)
64. + Oidemia fusca fusca (Linné). (Duc d'Orléans, 1909—Kara Sea.)
65. + Oidemia nigra nigra (Linné).
66. * Heniconetta (=Polysticta) stelleri (Pallas). (Zitkow, 1912.)
67. * Somateria mollissima mollissima (Linné).
68. * Erionetta (=Somateria) spectabilis (Linné). (Russian Polar Expedition, Birula, 1907.)
69. + **Merganser** (=**Mergus**) **merganser merganser** (Linné). (Ural Expedition, Wardropper-Backlund; Zitkow, 1912.)
70. + **Merganser** (=**Mergus**) **serrator** (Linné). (Zitkow, 1912.)
71. err. **Phalacrocorax carbo** (Linné). (Duc d'Orléans, 1909.)
72. M. K. Fulmarus glacialis glacialis (Linné). (Duc d'Orléans, 1909.)
73. * Urinator (=Gavia) stellatus (Pontoppidan).
74. * Urinator (=Gavia) arcticus arcticus (Linné).
75. * **Urinator** (=**Gavia**) **adamsi** (Gray). (Observed by Pr. Schirinsky, Schichmatow, see Zitkow and Buturlin, 1901.)

Our list can be compared in only a general way with Professor Palmén's, since he included the fauna of the Paë-choi range with that of Vaigach Island. The exact number of species which, from his lists, inhabit the regions in question cannot therefore be given precisely but I suppose that I shall not be far wrong in saying that our list of 75 species exceeds his by some ten species. Nos. 9, 22, and 47 still need more precise determination.

Of the total of 75 species, 67 or 89.33 per cent. have been found nesting and eight or

10.67 per cent are species that do not breed in the section (three of accidental occurrence and five that frequent the Kara Sea.)

Section XI. The Mouth of the Yenisei.

The tundra of the mouth of the Yenisei extends along the coast of the Arctic Ocean from the Mattesala promontory, situated in about north latitude 73° and east longitude 76°, takes in Yenisei Bay and ends on the east with Dickson Bay situated in latitude 73° 39′ north and longitude 80° 30′ east. Since Palmén's (1887, p. 484) description of the vegetation zones in the region of the mouth of the Yenisei is based on the original observations of Nordenskjöld, Arnell and Brenner, it must be regarded as quite correct and may be reproduced without any changes whatever, as follows:

The forest zone is composed of various species of trees with acicular leaves, while among the broad-leaved species the chief ones are birches; *Larix sibirica* occurs as far as Dudino (69° 25′ north latitude), still in the form of open woods. The northern limit of the larch which passes to the south of Tas Bay (in latitude 66° north), rises after this and reaches the indentation formed by the Yenisei between 69° 40′ and 70° north latitude where single trees still occur along the course of the river. On the left bank of the river the stunted forests are no longer seen near the mouth of the Cheta (69° 40′ north) and on the right bank near Malyshevskaja (70° north) situated between Krestorskoje and Seljakina. The west bank of the river is low and in spring may have the appearance either of islands partly submerged, or of marshy places, or again of dense thickets of *Alnaster* or of low willows. These thickets on both banks of the stream continue far beyond the northern limit of the coniferous forest. They are of rather stout growth as far north as Cape Tolstoi-nos (north latitude 70° 10′) and as far as Nikandrovsk (north latitude 70° 40′) on the eastern bank, while on the Brechovskije Islands (70°–71°) and near Mesenkino (71° 28′) they are almost as high as a man but near Koreopovskoje (71° 40′), Sverevskoje (71° 36′), Golchiha (71° 40′), and Krestovskoje (72° 24′) they become creeping. In the last-mentioned locality, however, one nevertheless still finds stout bushes of *Salix lanata*.

From this description we may conclude that the northern frontier of the forests crosses the Yenisei in latitude 69° 25′ north, and that between 69° 25′ and about 71° 40′ to 72° 24′ north, there is a rather wide belt that belongs to the subalpine zone. The tundra, which first appears much farther south in the shape of cut-off areas or islands, occupies the portion of the delta situated north of 71° 40′, and belongs for the greater part to the lowest section of the alpine zone (*Regio alpina α salicum*), though to a slight extent to the middle section (*Regio alpina β camporum nudorum*). I have therefore determined to consider those species only that occur beyond (to the northward) of Golchiha.

For an excellent sketch of the bird life of the lower Yenisei, the reader is referred to Seebohm's book, Siberia in Asia.

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Birds of the Mouth of the Yenisei.[1]

1.	err.	Corvus corax corax Linné. (To 72° north.)
2.	+	**Aegiothus** (=**Acanthis**) **hornemanni exilipes** (Coues). To 72° 30′ north according to Zitkow (1912).
3.	+?	Aegiothus (=Acanthis) linaria linaria (Linné).
4.	*	Plectrophenax nivalis nivalis (Linné). Breeds to the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Birula, 1907; Walter, *in litt.*).
5.	*	Calcarius lapponicus lapponicus (Linné). North to 72°.
6.	*	Otocorys (=Eremophila) alpestris flava (Gmelin). Breeds north of 70° (Russian Polar Expedition—Dickson Bay—Walter, Birula, Kolomeitzeff, *ll. cc.*).
7.	+	Motacilla alba alba Linné. To the mouth of the river.
8.	+	**Motacilla alba ocularis** Swinhoe. North to 72° (Tugarinow, 1908; Lavrow, 1909).
9.	+	**Budytes flava borealis** (Sundevall). North to 72° 5′.
10.	+	Budytes citreola citreola (Pallas). North to 72°.
11.	*	Anthus cervinus (Pallas). Noted as far north as 73°; probably reaches the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, Birula, *ll. cc.*).
12.	+	Phylloscopus trochilus (Linné). North to 71° (Tugarinow, 1908).
13.	+	Phylloscopus tristis Blyth. North to 71° 40′ (Tugarinow, 1908).
14.	+	Reguloides superciliosus superciliosus (Gmelin) (=Phylloscopus humei praemium Mathews and Iredale). North to 70°.
15.	+	Turdus pilaris Linné. North to 70° 30′.
16.	+	Turdus iliacus Linné (=musicus Linné). North to 71°.
17.	+	Saxicola (=Oenanthe) oenanthe oenanthe (Linné). North to 73° 30′ (Russian Polar Expedition—Dickson Bay—Birula, Walter, *ll. cc.*).
18.	+	Cyanecula (=Luscinia) svecica svecica (Linné). North to 71°.
19.	*	Nyctea nyctea (Linné). North to the Arctic coast.
20.	*	Stercorarius pomarinus (Temminck). The same.
21.	+	Stercorarius crepidatus Banks (=parasiticus Linné). The same.
22.	*	**Stercorarius longicaudus** (Vieillot). The same (Russian Polar Expedition—Dickson Bay—Walter, *in litt.*).
?23.	err.	**Larus marinus** Linné. Northward of 71° 5′ (Popham, 1897).
24.	err.	**Larus fuscus fuscus** Linné. Taken by Popham, 1897, in latitude 71° 5′ north and identified by Howard Saunders.

[1] Species not listed by Professor Palmén are in bold-face type.

25. * Larus argentatus taimyrensis Buturlin. To the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, *in litt.*).
26. * Larus glaucus Brünnich (=hyperboreus Gunnerus). To the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, Birula, *ll. cc.*).
27. err. Larus canus canus Linné. Lavrow, 1909.
28. trsv. autumn. **Rissa rissa rissa** (Linné) (=**tridactyla tridactyla** (Linné)). (Russian Polar Expedition—Dickson Bay—Birula, *l.c.*)
29. Oc. Gl. **Pagophila eburnea** (Phipps). (Russian Polar Expedition—Dickson Bay—Walter, 1901.)
30. * Sterna macrura Naumann. North to the arctic coast (Russian Polar Expedition—Dickson Bay—Walter, *in litt.*).
31. * Arenaria interpres (Linné). North to the shores of the Arctic Ocean.
32. * **Squatarola helvetica** (Linné) (=**squatarola** (Linné)). North to the shores of the Arctic Ocean (Popham, Lavrow, *ll. cc.*).
33. * Charadrius pluvialis Linné (=apricarius Linné). North to the shores of the Arctic Ocean.
34. * Charadrius dominicus fulvus Gmelin. North to the shores of the Arctic Ocean.
35. * Eudromias (=Charadrius) morinellus (Linné). North to 73° 30′ (Russian Polar Expedition—Dickson Bay—Walter, *l.c.*).
36. * Aegialitis (=Charadrius) hiaticula tundrae Lowe. North to the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, Birula, *ll. cc.*).
37. + Limosa lapponica lapponica (Linné). North to 72° (Popham, 1898; Lavrow, 1909).
38. err. Totanus fuscus (Linné) (=Tringa erythropus (Pallas)). North to 72° (Popham, 1898; Lavrow, 1909).
39. err. Tringoides (=Tringa) hypoleucus (Linné). North to 71° 40′.
40. + Pavoncella (=Philomachus) pugnax (Linné). North to the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, Birula, *ll. cc.*).
41. * **Calidris arenaria** (Linné) (=Crocethia alba (Pallas)). North of 71° 40′ (Popham, 1897; Lavrow, 1909).
42. * Limonites (=Calidris) minuta minuta (Leisler). From latitude 71° 5′ north to the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, Birula, *ll. cc.*).
43. * Limonites (=Calidris) temminckii (Leisler). North to 72°.
44. * **Arquatella** (=**Calidris**) **maritima maritima** (Gmelin). Along the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, Birula, Toll, *ll. cc.*).
45. * Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)). From latitude 71° 5′ north to the shores of the Arctic Ocean.
46. * Pelidna (=Calidris) alpina alpina (Linné). North to the shores of the Arctic Ocean.
47. * Phalaropus hyperboreus (Linné) (=lobatus (Linné)). North to 72° 50′.
48. * **Crymophilus fulicarius** (Linné). To the shores of the Arctic Ocean.
49. * Lagopus lagopus (Linné) subsp.? or Lagopus lagopus koreni Thayer and Bangs? North to 73° 30′ (Russian Polar Expedition—Dickson Bay—Walter, 1901).
50. * Lagopus rupestris (Gmelin) (=Lagopus mutus pleskei Serebrowsky). From latitude 71° 5′ north to the shores of the Arctic Ocean (Russian Polar Expedition—beyond Dickson Bay—Walter, 1901).
51. * Falco peregrinus griseiventris Brehm. North to the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, 1901; Kolomeitzeff, 1902; Birula, 1907).
52. + Aesalon (=Falco) aesalon (Tunstall).
53. + Archibuteo (=Buteo) lagopus pallidus Menzbier.

54. * Cygnus bewickii bewickii Yarrell. Nests as far north as 72° (Tugarinow, 1908, under *C. musicus*).
55. + Melanonyx arvensis arvensis (Brehm) (=Anser fabalis (Latham)). Breeds as far north as 71° (Tugarinow, 1910).
56. + **Melanonyx segetum segetum** (Gmelin) (=**Anser fabalis** (Latham)). Breeds regularly between latitude 69° and 71° north, reaching 72° north (Tugarinow, 1908, 1910).
57. + **Melanonyx segetum** (=**Anser**) **serrirostris** (Swinhoe). Breeds in limited numbers (Tugarinow, 1908, 1910).
58. * Anser albifrons (Scopoli). Breeds between latitude 70° and 73° 30′ north (Russian Polar Expedition—Dickson Bay—Walter, 1901).
59. + Anser erythropus (Linné). North to 70°.
60. * **Branta bernicla bernicla** (Linné). From 71° 5′ north to the shores of the Arctic Ocean (Popham, 1897, 1898; Tugarinow, 1908, 1910; Lavrow, 1909).
61. * Rufibrenta (=Branta) ruficollis (Pallas). Breeds between latitude 70° and 74° north (Tugarinow, 1908, 1910; Lavrow, 1909).
62. + Mareca (=Anas) penelope (Linné).
63. + Nettion (=Anas) crecca (Linné).
64. + Nettion (=Anas) formosum (Georgi).
65. + Dafila (=Anas) acuta (Linné).
66. + Fuligula (=Nyroca) marila marila (Linné). To 72° north latitude.
67. * Harelda (=Clangula) glacialis (Linné). To the shores of the Arctic Ocean.
68. err. **Histrionicus histrionicus histrionicus** (Linné). (Hydrographic Expedition to the Arctic Ocean—Dickson Bay.)
69. + Oidemia fusca fusca (Linné).
70. + Oidemia nigra nigra (Linné).
71. * **Somateria mollissima mollissima** (Linné). Beyond 71° 5′ north latitude (Popham, 1897, 1898).
72. * Erionetta (=Somateria) spectabilis (Linné). Beyond 71° 5′ north latitude.
73. * Urinator (=Gavia) stellatus (Pontoppidan). To the shores of the Arctic Ocean (Russian Polar Expedition—Dickson Bay—Walter, Birula, *ll. cc.*).
74. * Urinator (=Gavia) arcticus arcticus (Linné). To 72° north latitude.
75. * Urinator (=Gavia) adamsi (Gray). Beyond 71° 5′ north latitude.

The list of birds of the mouth of the Yenisei includes 75 species, of which 18 are not given in Palmén's list; No. 23 (*Larus marinus* Linné) requires confirmation.

Of the total of 75 species recorded from the Yenisei delta, 66, or 88 per cent, have been found breeding there, while nine or 12 per cent, do not breed (seven are accidental, one is recorded as a migrant, and one frequents the Arctic Ocean in these latitudes).

Section XII. Western Part of the Taimyr Peninsula and Lonely Island (Ujedinenija).

The western part of the Taimyr Peninsula includes the land situated along the coast of the Arctic Ocean from Dickson Bay (73° 39′ north latitude and 80° 30′ east longitude) to the mouth of the Taimyr River in the bay of the same name (about 75° 10′ north latitude and 100° east longitude). A somewhat detailed description of the western Taimyr region and particularly of the country about the "Sarja's" first winter-quarters (76° 8′

north latitude and 95° 6′ east longitude) will be found in the account of the course of the Russian Polar Expedition, based on the original notes extracted from Birula's work. I may therefore confine myself here to pointing out that the northern limit of the forest region, after crossing the Yenisei near Golchiha (71° 40′ north latitude), swings obviously north in passing to the eastward and reaches the Arctic Ocean at the mouth of the Chatanga (in approximately 73° north latitude). Data are not at hand for tracing the northern limit of the subalpine zone in these regions or for determining its north-and-south extent; but I have no hesitation in expressing the opinion that the two parts (western and eastern) of the Taimyr peninsula are for the greater part taken up by the tundra and especially by its lower section (*Regio alpina α salicum*) in the less elevated portions, and by the middle section (*Regio alpina β camporum nudorum*) in the higher areas. Outside the Siberian mainland, this section includes Lonely Island (Ujedinenija), situated in the Arctic Ocean between 77° 31′ and 77° 42′ north latitude. It was discovered by Captain Johannesen and described by Professor Mohn (Die Insel Einsamkeit, Peterm. Geogr. Mitth., 1879, p. 57–59). This island with its precipitous coasts serves as a breeding place for several species of birds, such as the Fulmar, and probably for the Ivory Gull, *Pagophila eburnea* (Phipps), and *Cepphus mandti* (Lichtenstein).

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List of Birds of Western Taimyr.[1]

1. * Plectrophenax nivalis nivalis (Linné). To the shores of the Arctic Ocean (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*).
2. * Calcarius lapponicus lapponicus (Linné). Recorded as far north as latitude 76° 8′ (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*).
3. \+ Motacilla alba ocularis Swinhoe. As far north as latitude 74°.
4. \+ Anthus cervinus (Pallas). Recorded as far north as 76° 8′ (Russian Polar Expedition—Walter, Birula, *ll. cc.*).
5. err. **Periparus** (=**Parus**) **ater ater** (Linné). (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
6. \+ Saxicola (=Oenanthe) oenanthe oenanthe (Linné). As far north as latitude 74° 45′.
7. * Nyctea nyctea (Linné). To the shores of the Arctic Ocean (Russian Polar Expedition—Walter, Birula, *ll. cc.*).
8. *?hib. Oc. Gl. Cepphus mandti (Lichtenstein). Perhaps nesting on Lonely Island and certainly wintering in the Arctic Ocean.
9. * Stercorarius pomarinus (Temminck). Recorded as far north as latitude 76° 8′ (Russian Polar Expedition—Walter, Birula, *ll. cc.*).
10. \+ Stercorarius crepidatus Banks (=parasiticus Linné). As far north as latitude 76° 20′ (Russian Polar Expedition—Walter, Birula, *ll. cc.*).
11. * Stercorarius longicaudus (Vieillot). Recorded as far north as latitude 76° 8′ (Russian Polar Expedition—Walter, Birula, *ll. cc.*).
12. err. **Larus argentatus antelius** Iredale. (Russian Polar Expedition—Middendorff Bay—Walter, *in litt.*; anchorage of the "Sarja" (Toll, *l.c.*)).
13. * **Larus argentatus taimyrensis** (Buturlin). (Middendorff—Taimyr River and Boganida), partim **L. argentatus birulai** Sushkin ♀ or hybrid with **L. argentatus taimyrensis** (Buturlin).
14. * **Larus argentatus birulai** Sushkin or hybrid with **Larus argentatus taimyrensis** Buturlin. To the shores of the Arctic Ocean (Russian Polar Expedition: Walter, *l.c.*, sub *L. argentatus* Linné et *affinis* Reinhardt (?) et Birula, *l.c.*, sub *L. vegae* Palmén et *L. cachinnans* Pallas var.)
15. * Larus glaucus Brünnich (=hyperboreus Gunnerus). To the shores of the Arctic Ocean (Russian Polar Expedition—Walter, Birula, *ll. cc.*).

[1] Species not listed by Professor Palmén are in bold-face type.

16. hib. Oc. Gl. Rissa rissa rissa (Linné) (=Rissa tridactyla tridactyla (Linné)). Recorded in latitude 76° 20′ north (Russian Polar Expedition—Walter, *l.c.*).
17. \+ Xema sabini (J. Sabine). To latitude 74° north.
18. hib. Oc. Gl. Pagophila eburnea (Phipps). Perhaps nesting on Lonely Island (Russian Polar Expedition—Walter, Birula, *ll. cc.*).
19. \+ Sterna macrura Naumann. (Russian Polar Expedition—Walter, Birula, *ll. cc.*)
20. * Arenaria interpres (Linné). To the shores of the Arctic Ocean (Russian Polar Expedition—to 76° 20′ north latitude, 95° 14′ east longitude—Walter, Birula, *ll. cc.*).
21. * Squatarola helvetica (Linné) (=squatarola (Linné). (Russian Polar Expedition—Walter, Birula, *ll. cc.*)
22. \+ Charadrius dominicus fulvus Gmelin. (Russian Polar Expedition—Walter, 1901, sub *Ch. pluvialis*).
23. * Eudromias (=Charadrius) morinellus (Linné). (Russian Polar Expedition—Walter, Birula, *ll. cc.*)
24. \+ Aegialitis (=Charadrius) hiaticula tundrae Lowe. As far as north latitude 74° 30′.
25. \+ Limosa lapponica lapponica (Linné). (Russian Polar Expedition—Walter, Birula, *ll. cc.*; Palmén sub *Limosa lapponica* v. *novae zealandiae* Gray).
?26. err. **Glottis (=Tringa) nebularius** (Gunnerus). (Nansen—Renö Isle—Collett and Nansen, 1899.)
27. \+ Pavoncella (=Philomachus) pugnax (Linné). (Russian Polar Expedition—Walter, Birula, *ll. cc.*)
28. * Calidris arenaria (Linné) (=Crocethia alba (Pallas). (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
29. err. **Heteropygia (=Calidris) maculata** (Vieillot). (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
30. * Limonites (=Calidris) minuta minuta (Leisler). (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
31. * Limonites (=Calidris) temminckii (Leisler). As far north as latitude 76° 15′.
32. * Arquatella (=Calidris) maritima maritima (Gmelin). Along the shores of the Arctic Ocean (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*).
33. * Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)). (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
34. * Tringa (=Calidris) canutus Linné. (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
35. \+ Pelidna (=Calidris) alpina alpina (Linné). (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
36. \+ **Gallinago** (=**Capella**) sp.? (Russian Polar Expedition—Walter.)
37. \+ Phalaropus hyperboreus (Linné) (=lobatus (Linné)). (Nansen—Renö Isle, 74° 46′ north latitude—Collett and Nansen, 1899).
38. * Crymophilus fulicarius (Linné). (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*)
39. * Lagopus rupestris (Gmelin) =Lagopus mutus pleskei Serebrowsky. (Russian Polar Expedition—Walter, Birula, *ll. cc.* sub *Lagopus mutus* Montin.)
40. \+ Hierofalco(=Falco) sp.? As far north as latitude 75° 30′.
?41. \+ Aesalon (=Falco) aesalon (Tunstall). (Nansen, 1899; Russian Polar Expedition—Walter, 1901.)
42. \+ Haliaëtus (=Haliaeëtus) albicilla (Linné). To 75° north latitude.
43. * Cygnus bewickii bewickii Yarrell. (Palmén, 1887, sub *C. musicus;* breeds as far north as 74° 30′, accidental as far as 75° 52′. Russian Polar Expedition, Walter, *l.c.*)
44. \+ Melanonyx arvensis (=Anser fabalis) sibiricus Alphéraki. North to latitude 74°.
45. * Anser albifrons (Scopoli). North to latitude 74°.

46. + Anser erythropus (Linné). North to 74°.
47. * Branta bernicla bernicla (Linné). (Russian Polar Expedition—Walter, Birula, *ll. cc.*)
48. * Rufibrenta (=Branta) ruficollis (Pallas). North to latitude 73° 40′.
49. err. **Dafila** (=**Anas**) **acuta** (Linné). (Russian Polar Expedition—Middendorff Bay—Walter, *l.c.*)
50. * Harelda (=Clangula) glacialis (Linné). To latitude 76° 15′ north (Russian Polar Expedition—Walter, Birula, *ll. cc.*).
51. + Oidemia nigra nigra (Linné). North to 73° 45′.
52. + Heniconetta (=Polysticta) stelleri (Pallas). North to 74°.
53. * Erionetta (=Somateria) spectabilis (Linné). (Russian Polar Expedition—Walter, Birula, *ll. cc.*)
54. * **Fulmarus glacialis glacialis** (Linné). On Lonely Island.
55. * Urinator (=Gavia) stellatus (Pontoppidan). (Russian Polar Expedition—Walter, Birula, *ll. cc.*)
56. * Urinator (=Gavia) arcticus arcticus (Linné). North to 74°.
57. * Urinator (=Gavia) adamsi (Gray). (Russian Polar Expedition—Walter, Birula, Toll, *ll.cc.*)

The list of birds of Western Taimyr and Lonely Island comprises in all 57 species, of which eight are not found in the lists of Professor Palmén (*l.c*). I have also thought best to eliminate from his list the following species: *Larus leucopterus* Faber (=*glaucoides* Meyer), *Cygnus cygnus cygnus* (Linné), *Branta leucopsis* (Bechstein) and *Urinator* (=*Gavia*) *immer* (Brünnich). Of the total number listed, one species, No. 26, still requires definite confirmation, while in the case of the Gerfalcon (No. 40), and the Snipe (No. 36) a precise identification of the species was not possible. Of the total of 57 species recorded from Western Taimyr, 49 or 85.9 per cent breed there, while eight species or 14.1 per cent occur outside of the breeding season or accidentally.

Section XIII. Eastern Part of the Taimyr Peninsula and Emperor Nicholas II Land.

The Eastern Taimyr section is bounded on the west by the delta of the Taimyr River in the Arctic Ocean (approximately in 75° 10′ north latitude and 100° east longitude), and on the east by the mouth of the Anabara (about 72° 12′ north latitude and 113° east longitude). This portion of the Eurasian tundra is the least known ornithologically as appears from the fact that Professor Palmén's (1887) list includes but 16 species recorded for this region at that time. Thanks chiefly to the fairly large collections brought back in more recent times by the Hydrographic Expedition to the Arctic Ocean, and to the labors of the two physicians of this expedition, Drs. Arnhold and Starokadomski, we are now in a position to add to Professor Palmén's list no less than 23 species, making a total of 39 species. This number, however, represents only about two-thirds of the fauna of the neighboring Section of Western Taimyr and must obviously be regarded as only partial for the determination of the elements in the bird fauna of this region. In addition to the continental portion, this section further includes Emperor Nicholas II Land,

discovered by Captain Wilkitzky, commander of the Hydrographic Expedition to the Arctic Ocean, and situated to the north of Cape Cheljuskin. The extreme southeastern point of this land whence we at present know but a single species of bird—*Larus argentatus birulai* Sushkin—is situated in approximately 77° 50′ north latitude and 99° east longitude. As I have already mentioned in the account of the western part of Taimyr, the northern limit of the forest zone, after crossing the Yenisei in north latitude 71° 40′, swings northward, south of the Taimyr peninsula, to the mouth of the Chatanga in about north latitude 73°; from there it again drops and cuts the 110th meridian in approximately 70° north. I am not in a position to define the boundary of the subalpine zone in these latitudes. The northern part of this peninsula belongs to the tundra and is undoubtedly of the same character as the corresponding portions of Western Taimyr. It remains to mention the isle Preobrashenije situated in the outmost part of the mouth of the Chatanga. This island with its high precipitous shores, serves as a nesting place for Gulls and Guillemots, and is of particular interest since it is inhabited not by the western form of the Guillemot, *Uria lomvia lomvia* (Linné), but by the eastern form, *Uria lomvia arra* (Pallas).

Literature.

The list by Professor **J. A. Palmén** (1887, p. 486) may be completed by the following works:

1. 1907. **Buturlin, S.** [Interesting finds.] Venery and Hunting, 1907, p. 92–100 (in Russian).
2. 1908. **Buturlin, S.** [The Bean Geese.] Our Hunting, 1908, no. 11, p. 27 (in Russian).
3. 1908. **Buturlin, S.** Bemerkungen über die geographische Verbreitung der Vögel im nordöstlichen Sibirien. Journ. f. Ornith., vol. 56, p. 282–294; p. 294, Anmerkungen dazu von **H. Schalow.**
4. 1909. **Toll, Baron Ed. von.** Die russische Polarfahrt der "Sarja" 1900–1902. Aus den hinterlassenen Tagebüchern von. Berlin, 8vo.
5. 1910. **Tugarinow, A.** [The Geese of the lower Yenisei.] Mess. Ornith., p. 44–49 (in Russian).
6. 1911. **Buturlin, S.** *Larus affinis taimyrensis*, subsp. nova. Mess. Ornith., p. 149.
7. 1915. **Starokadomski, L.** . [The discovery of unknown land in the Arctic Ocean.] Edited by the Marine-Revue, Petrograd, 8vo. Birds, p. 28 (in Russian).
8. 1916. **Starokadomski, L.** [Through the Arctic Ocean, from Wladiwostok to Archangel.] Petrograd, 8vo. Birds, pp. 14, 66 (in Russian).
9. 1916. **Trzemesski, J.** [Expedition of the "Eclipse" in search of the expeditions of Lieutenant Brussilow and the geologist Russanow. (Preliminary report).] Petrograd, 8vo (in Russian).
10. 1916. **Nasonow, N.** [Zoölogical collections made by the Hydrographic Expedition to the Arctic Ocean on the steamers "Taimyr" and "Vaigach" in 1910–15, transmitted to the Zoölogical Museum of the Academy of Sciences.] Bull. Acad. Sci. St. Pétersbourg, ser. 6, vol. 16, p. 1493–1504. (Report on birds by **V. Bianchi,** p. 1494–1496, in Russian.)

List of Birds of Eastern Taimyr.[1]

1. err. **Cynchramus** (=**Emberiza**) **schoeniclus polaris** (Middendorff). Hydrographic Expedition to Arctic Ocean, 15 leagues from latitude 76° 40′ north, longitude 100° 20′ east.

[1] Species not listed by Professor Palmén are in bold-face type.

2. * **Plectrophenax nivalis nivalis** (Linné). (73° 30′ to 76° 30′ north latitude, Russian Polar Expedition—Cape Cheljuskin (Birula, 1907); Hydrographic Expedition to Arctic Ocean—Preobrashenije Island, 76° 40′ north latitude, 100° 58′ east longitude; Dick Bay, 76° 30′ north, 100° 50′ east.)
3. * **Calcarius lapponicus lapponicus** (Linné). Hydrographic Expedition—Preobrashenije Island, 76° 40′ north latitude, 100° 58′ east longitude.
4. err. **Anthus trivialis hodgsoni** Richmond. Hydrographic Expedition to Arctic Ocean—King Oskar Land, 76° 33′ north latitude, 99° 38′ east longitude; 76° 45′ north latitude, 100° 30′ east longitude.
5. err. **Reguloides superciliosus superciliosus** (Gmelin) (=**Phylloscopus humei praemium** Mathews and Iredale). Hydrographic Expedition to Arctic Ocean—near King Oskar Land, 15 leagues from 76° 40′ north and 100° 58′ east.
6. + **Saxicola** (=**Oenanthe**) **oenanthe oenanthe** (Linné). Hydrographic Expedition to Arctic Ocean—same place.
7. + **Cyanecula** (=**Luscinia**) **svecica robusta** Buturlin. (Middendorff, 1843.)
8. * Nyctea nyctea (Linné). 74° 45′ to 77° 30′ north latitude.
9. * Uria lomvia arra (Pallas). (Russian Polar Expedition—Birula, *l.c.*)
10. * Cepphus mandti (Lichtenstein). (Russian Polar Expedition—Birula, *l.c.*)
11. * **Stercorarius pomarinus** (Temminck). Hydrographic Expedition to Arctic Ocean—76° 33′ north latitude, 99° 50′ east longitude; Dick Bay; and 76° 40′ north latitude, 100° 58′ east longitude.
12. + Stercorarius crepidatus Banks (=parasiticus Linné). 74° north latitude.
13. * Stercorarius longicaudus (Vieillot). To 77° 30′ north latitude.
14. * Larus glaucus Brünnich (=hyperboreus Gunnerus). Between 74° 45′ and 77° 30′ north latitude.
15. + **Larus argentatus taimyrensis** Buturlin. (Chatanga Expedition of Tolmacheff—coll. by Tolstow.)
16. * **Larus argentatus birulai** Sushkin. Hydrographic Expedition to Arctic Ocean—76° 40′ north latitude, 100° 58′ east longitude; 76° 48′ north, 100° 50′ east; Nicholas II Land.
17. * Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)). 73° 40′ to 77° 45′ north latitude (Russian Polar Expedition—Walter, Birula, Toll, *ll. cc.*).
18. + Xema sabini (J. Sabine). (?Russian Polar Expedition—?St. Paul Island, Birula, 1907.)
19. hib. Oc. Gl. **Pagophila eburnea** (Phipps). Hydrographic Expedition to Arctic Ocean, 77° 14′ north latitude, 101° 24′ east longitude; Russian Polar Expedition—Birula, *l.c.*; ?St. Paul Island.
20. * Sterna macrura Naumann. Hydrographic Expedition to Arctic Ocean—Dick Bay; 76° 40′ north latitude, 100° 58′ east longitude.
21. * **Arenaria interpres** (Linné). Hydrographic Expedition to Arctic Ocean; 76° 40′ north latitude, 100° 58′ east longitude; 76° 48′ north, 100° 50′ east.
22. * **Eudromias** (=**Charadrius**) **morinellus** (Linné). Hydrographic Expedition to Arctic Ocean—Dick Bay; 76° 48′ north latitude, 100° 50′ east longitude; 76° 40′ north, 100° 58′ east; Paquet Cape, Chatanga Bay.
23. + **Aegialitis** (=**Charadrius**) **hiaticula tundrae** Lowe. Hydrographic Expedition to Arctic Ocean—Dick Bay; 76° 48′ north latitude, 100° 50′ east longitude.
24. * **Calidris arenaria** (Linné) (=**Crocethia alba** (Pallas)). North to latitude 77° 45′ (Hydrographic Expedition to Arctic Ocean in 1915).
25. err. Heteropygia (=Calidris) maculata (Vieillot). To 77° 45′ north latitude.
26. * **Limonites** (=**Calidris**) **minuta minuta** (Leisler). In 76° 40′ north latitude, 100° 58′ east longitude (Hydrographic Expedition to Arctic Ocean).

27. err. **Limonites (=Calidris) minuta ruficollis** (Pallas). Same place (Hydrographic Expedition to Arctic Ocean).
28. * Arquatella (=Calidris) maritima maritima (Gmelin). Along the shores of the Arctic Ocean to latitude 77° 45′ north (Russian Polar Expedition—Cape Cheljuskin—Walter, Birula, *ll. cc.*).
29. + **Phalaropus hyperboreus** (Linné) (=**lobatus** (Linné)). Hydrographic Expedition to Arctic Ocean—76° 40′ north latitude, 100° 58′ east longitude.
30. * Crymophilus fulicarius (Linné). From 73° 40′ to 78° 1′ north latitude (Russian Polar Expedition—Birula, Toll, *ll. cc.*).
31. * Lagopus rupestris (Gmelin)=Lagopus mutus pleskei Serebrowsky. Hydrographic Expedition to Arctic Ocean—King Oskar Land, Haffner Bay (76° 48′ north latitude, 100° 50′ east longitude); Dick Bay; 76° 40′ north latitude, 100° 58′ east longitude).
32. * Branta bernicla bernicla (Linné). North to latitude 77° 36′.
33. * **Rufibrenta (=Branta) ruficollis** (Pallas). (Tugarinow, 1910.)
34. * **Harelda (=Clangula) glacialis** (Linné). Hydrographic Expedition to Arctic Ocean—76° 40′ north latitude, 100° 58′ east longitude.
35. + **Oidemia fusca stejnegeri** (Ridgway). Scientific Expedition to the Chatanga under Tolmatcheff—specimen in our Zoölogical Museum.
36. + **Heniconetta (=Polysticta) stelleri** Pallas. Hydrographic Expedition to Arctic Ocean—Dick Bay, 76° 48′ north latitude, 100° 50′ east longitude.
37. * Erionetta (=Somateria) spectabilis (Linné).
38. Oc. Gl. **Fulmarus glacialis glacialis** (Linné). Russian Polar Expedition—between Eastern Taimyr and Bennett Island—Birula, 1907.
39. * Urinator (=Gavia) stellatus (Pontoppidan).

This list shows us that of the total number of 39 species recorded for Eastern Taimyr, 32 or 82 per cent breed there and seven or 18 per cent frequent these regions outside the breeding season or casually.

Section XIV. The Mouth of the Lena.

The section comprising the mouth of the Lena extends along the shores of the Arctic Ocean from the mouth of the Anabara, in approximately 72° 12′ north latitude and 113° east longitude, to the southern point of Borchaja Bay at about 70° 42′ north latitude and 131° 40′ east longitude. In addition to the older observations and the material brought back by Dr. Bunge from his stay at the mouth of the Lena (chiefly at Sagastyr in 73° 22′ north latitude) in the years 1882, 1883 and 1884, we now have at our disposal the collections of the Russian Polar Expedition made by Brusneff in 1902, mainly in the region of the Charaulach range, and by Naval Lieutenant Th. Matiessen during his visit to Tiksi Bay late in the year 1902.

The northern boundary of the forest region cuts the Anabara River in very nearly 70° north latitude, rises to the eastward and crosses the Olenek at about 72° north latitude. Thence it descends again toward the Lena, and crosses the course of this river in 71° north latitude. Along the banks of the stream itself, however, a forest vegetation extends in a narrow strip to Tit-ary Island, situated in latitude 72° north. The river-mouth

itself is quite without forests and presents low sand dunes or hills of slight elevation covered with grasses and moss and on their southern slopes with willows. In these regions the close proximity of the forest and the subalpine regions to the shores of the Arctic Ocean is at once evident from the fact that the lower part of the alpine zone which appears at the mouth of the river and in the higher of the surrounding mountains, is frequented by a very considerable number of bird species that do not belong to the fauna of the tundra, properly speaking. It is due to this fact that the list of birds recorded from the region of the Lena's mouth reaches the number of 73 species.

Literature.

The list of publications cited in Professor **Palmén's** work (1887, p. 487) may be completed by the following:

1. 1861. **Argentoff, A.** [On the birds of the country situated beyond the Lena.] Acclimatation vol. 2, p. 481–496 (in Russian).
2. 1887. **Bunge, Dr. Alexander.** Brief an den beständigen Sekretär der Akademie über den Gang der von ihr veranstalteten Expedition nach den Neusibirischen Inseln und dem Jana-Lande. Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 119–139.
3. 1888. **Newcomb, R. L.** Our lost explorers: the narrative of the "Jeanette" Arctic Expedition, as related by the survivors, and in the records and last journals of Lieutenant DeLong. Hartford, Conn., 8vo.
4. 1904. **Brusneff, M.** [Report of the Chief of the expedition to the archipelago of New Siberia for the rescue of Baron Toll, with a map of the itinerary. Account of the results of the Russian Polar Expedition, conducted by Baron Toll.] Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 161–194 (in Russian).
5. 1904. **Matiessen, Th.** [Report of Lieutenant of Marine Th. Matiessen, commander of the steamer "Sarja", to his Highness the President of the Academy of Sciences. Account of the results of the Russian Polar Expedition, conducted by Baron Toll.] Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 2, p. 55–65 (in Russian).
6. 1907. **Birula, A.** [Sketches of bird life on the north coast of Siberia. With 8 plates and 23 figures in text. Scientific results of the Russian Polar Expedition of 1900–1902 conducted by Baron E. Toll. Zoölogical Section, vol. 1, livr. 2.] Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2 (in Russian).
7. 1907. **Buturlin, S.** [Interesting finds.] Venery and Hunting, p. 92–100 (in Russian).
8. 1907. **Buturlin, S. A.** [On the Swans of Northern Asia.] Ibis, ser. 9, vol. 1, p. 650–652.
9. 1908. **Buturlin, S.** [The Bean Geese.] Our Hunting, 1908, no. 11, p. 21–28 (in Russian).
10. 1908. **Buturlin, S. A.** Bemerkungen über die geographische Verbreitung der Vögel im nordöstlichen Sibirien. Journ. f. Ornith., vol. 56, p. 282–294: Anmerkungen dazu von **H. Schalow.**
11. 1908. **Dresser, H. E.** Further notes on rare palaearctic birds' eggs. Ibis, ser. 9, vol. 2, p. 486–490, pl. 10.
12. 1910. **Dresser, H. E.** Eggs of the birds of Europe, including all the species inhabiting the western palaearctic area. London, 4to, 2 vols.

List of Birds of the Mouth of the Lena.[1]

1. \+ Corvus corax corax Linné. 72° north latitude (Russian Polar Expedition—Kolchak).
2. \+ **Aegiothus (=Acanthis) hornemanni exilipes** (Coues). (Russian Polar Expedition—Brusneff.)

[1] Species not listed by Professor Palmén are printed in bold-face type.

3. * Plectrophenax nivalis nivalis (Linné). (Russian Polar Expedition—Brusneff.)
4. * Calcarius lapponicus lapponicus (Linné). (Russian Polar Expedition—Brusneff, Matiessen; Bunge, Mél. Biol. Acad. Sci. St. Pétersbourg, vol. 11, p. 596, 1883, sub *Emberiza* sp.?)
5. * **Otocorys** (=**Eremophila**) **alpestris flava** (Gmelin). (Russian Polar Expedition—Brusneff.)
6. + Motacilla alba ocularis Swinhoe. (Russian Polar Expedition—Brusneff.)
7. + **Budytes flava borealis** (Sundevall). (Russian Polar Expedition—Brusneff.)
8. * Anthus cervinus (Pallas). (Russian Polar Expedition—Brusneff.)
9. + **Anthus spinoletta japonicus** Temminck and Schlegel. (Buturlin, 1908.)
10. + Saxicola (=Oenanthe) oenanthe oenanthe (Linné). (Russian Polar Expedition—Brusneff.)
11. + **Cyanecula** (=**Luscinia**) **svecica robusta** Buturlin. (Buturlin, 1908.)
12. * Nyctea nyctea (Linné). (Russian Polar Expedition—Brusneff, Kolchak.)
13. + **Asio accipitrinus** (Pallas) (=**flammeus** (Pontopiddan)). (Russian Polar Expedition—Brusneff; Birula, 1907.)
14. hib. Oc. Gl. **Uria lomvia arra** (Pallas). (Hydrographic Expedition to Arctic Ocean.)
15. + Stercorarius pomarinus (Temminck). (Russian Polar Expedition—Brusneff.)
16. + Stercorarius crepidatus Banks (=parasiticus Linné).
17. * Stercorarius longicaudus (Vieillot). (Russian Polar Expedition—Brusneff.)
18. * Larus glaucus Brünnich (=hyperboreus Gunnerus). (Russian Polar Expedition—Brusneff.)
19. * Larus argentatus birulai Sushkin. (Bunge, sub *L. argentatus* et partim sub *L. glaucus;* Russian Polar Expedition—Brusneff.)
20. + Xema sabini (J. Sabine).
21. hib. Oc. Gl. Pagophila eburnea (Phipps). 73° 22′ north latitude.
22. err. Rhodostethia rosea (Macgillivray). 73° 22′ north latitude.
23. * Sterna macrura Naumann. (Bunge sub *Sterna macrura* et *S. hirundo.*)
24. * Arenaria interpres (Linné). Between north latitude 72° and 73° 22′.
25. * Squatarola helvetica (Linné) (=squatarola (Linné)). Between north latitude 72° and 73° 22′.
26. * Charadrius dominicus fulvus Gmelin. (Russian Polar Expedition—Brusneff.)
27. * Eudromias (=Charadrius) morinellus (Linné). (Russian Polar Expedition—Brusneff.)
28. + **Aegialitis** (=**Charadrius**) **hiaticula tundrae** Lowe. (Russian Polar Expedition—Brusneff; Hydrographic Expedition to Arctic Ocean—Tiksi Bay.)
29. + **Limosa lapponica lapponica** (Linné).
?30. err. Glottis (=Tringa) nebularius (Gunnerus).
31. + Pavoncella (=Philomachus) pugnax (Linné). (Russian Polar Expedition—Brusneff.)
32. * Calidris arenaria (Linné) (=Crocethia alba (Pallas)). North to latitude 73° 22′.
33. + **Heteropygia** (=**Calidris**) **maculata** (Vieillot). (Bunge, *ll. cc.* sub *Tringa maritima* (partim?) et *Tringa alpina;* Russian Polar Expedition—Brusneff.)
34. trsv. **Heteropygia** (=**Calidris**) **acuminata** (Horsfield). (Buturlin, Journ. f. Ornith., vol. 56, p. 293, 1908.)
35. * Limonites (=Calidris) minuta minuta (Leisler). North to latitude 73° 22′.
36. err. Limonites (=Calidris) minuta ruficollis (Pallas). North to latitude 73° 22′.
37. + Limonites (=Calidris) temminckii (Leisler). North to latitude 73° 22′.
?38. + Arquatella (=Calidris) maritima maritima (Gmelin). An egg, probably of this species, brought by Bunge from the mouth of the Lena.
39. trsv. Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)). (Russian Polar Expedition—Brusneff.)
40. + Pelidna (=Calidris) alpina alpina (Linné). (Russian Polar Expedition—Brusneff.)
41. + Gallinago (=Capella) gallinago raddei Buturlin. (Bunge sub *Scolopax* sp.?).
42. + Phalaropus hyperboreus (Linné) (=lobatus (Linné)). (Russian Polar Expedition—Brusneff.)

43. * Crymophilus fulicarius (Linné). (Russian Polar Expedition—Brusneff.)
44. * Lagopus lagopus subsp.? (Linné) or Lagopus lagopus koreni Thayer and Bangs?
45. * Lagopus rupestris (Gmelin) = Lagopus mutus pleskei Serebrowsky.
46. + Hierofalco (= Falco) islandus (Brünnich). North to latitude 73° 25′ (Bunge sub *Hierofalco gyrfalco*).
47. + **Hierofalco** (= **Falco**) **candicans** (Gmelin). (Toll, 1893—specimen in our Zoölogical Museum.)
48. * Falco peregrinus griseiventris Brehm. (Russian Polar Expedition—Brusneff.)
?49. + Aesalon (= Falco) aesalon (Tunstall). 73° 25′ north latitude.
?50. + Haliaëtus (= Haliaëtus) albicilla (Linné).
51. * Archibuteo (= Buteo) lagopus pallidus Menzbier. (Russian Polar Expedition—Brusneff, Matiessen.)
?52. + Cygnus cygnus cygnus (Linné).
53. * Cygnus bewickii bewickii Yarrell.
54. * **Cygnus bewickii jankowskii** Alphéraki. (Buturlin, 1907; Russian Polar Expedition—Brusneff, Matiessen.)
55. err. **Chen hyperboreus hyperboreus** (Pallas). (Russian Polar Expedition—Birula, 1907.)
56. * Melanonyx arvensis (= Anser fabalis (Latham)) sibiricus Alphéraki. To the shores of the Arctic Ocean (Buturlin, 1908; Russian Polar Expedition—Matiessen).
57. + Melanonyx segetum (= Anser fabalis) serrirostris (Swinhoe). (Buturlin, 1908.)
58. * Anser albifrons (Scopoli). (Russian Polar Expedition—Brusneff.)
59. + **Anser erythropus** Linné.
60. * Branta bernicla nigricans (Lawrence).
61. + Mareca (= Anas) penelope (Linné).
62. + Nettion (= Anas) crecca (Linné). (Russian Polar Expedition—Brusneff.)
63. + Nettion (= Anas) formosum (Georgi).
64. + **Dafila** (= **Anas**) **acuta** (Linné). (Russian Polar Expedition—Brusneff.)
65. * Harelda (= Clangula) glacialis (Linné). (Russian Polar Expedition—Brusneff, Matiessen.)
66. + **Oidemia nigra americana** (Swainson and Richardson). (Buturlin in Dresser's Eggs Birds Europe, p. 579, 1910.)
67. * Heniconetta (= Polysticta) stelleri (Pallas).
68. + **Arctonetta fischeri** (Brandt). (Russian Polar Expedition—Birula, 1907.)
69. + Somateria mollissima v-nigrum Gray.
70. * Erionetta (= Somateria) spectabilis (Linné).
71. err. Phalacrocorax sp.?—(Probably *Phalacrocorax pelagicus* (Pallas)?). In latitude 73° 25′ north.
72. * Urinator (= Gavia) stellatus (Pontoppidan). (Russian Polar Expedition—Brusneff.)
73. + **Urinator** (= **Gavia**) **arcticus arcticus** (Linné). (Russian Polar Expedition—Brusneff.)

Professor Palmén's list of the birds characteristic of that part of the Lena's mouth bare of forest vegetation, comprises but 56 species, of which two—*Larus leucopterus* Faber and *Cygnus olor* (Linné)— should in my opinion be excluded. Furthermore, I suggest changing the identification of his *Hierofalco gyrfalco* (Linné) taken by Dr. Bunge, to *Hierofalco* (= *Falco*) *islandus* (Brünnich); that of his *Oidemia nigra* (Linné) to *Oidemia nigra americana* (Swainson and Richardson). I am able to add to the faunal list of the section 19 species, making a total of 73 species recognized as occurring in this section of the Eurasian tundra. Of this number, five species, included as Nos. 30, 38, 49, 50, 52, require further confirmation as to their occurrence. Of the total number of 73 species

recorded from the region of the mouth of the Lena, 64 species or 87.67 per cent nest there, while nine species or 12.33 per cent are found either at times other than the breeding season or casually.

Section XV. The Mouth of the Yana.

The section comprising the mouth of the Yana extends from the most southerly point of Borchaja Bay, in approximately latitude 70° 42′ north and longitude 131° 40′ east, to the southern end of Chromskaja Bay in about latitude 71° 40′ north and 145° 12′ east. In addition to the older observations on the ornithological fauna of the lower Yana, made by Dr. Bunge in 1885 (Bunge, 1887), we have available a rather large amount of data obtained by Birula (1907) from the natives of these latitudes.

The northern limit of the forest zone in this section extends along the 71st parallel, cutting the Yana near Chrestjach (71° 15′ north latitude) and the tundra is represented in these latitudes by but a relatively narrow band which broadens out only toward the Swjatoi Noss promontory and Chromskaja Bay. The thicket zone (*Regio subalpina*) must come very close to the shores of the Arctic Ocean and perhaps even reaches it at times. The ornithological fauna of these portions of the tundra must obviously therefore be intermixed with a number of species characteristic of the subalpine and even of the forest zone.

Literature.

Professor **Palmén's** list (1877, p. 488) may be completed by the following works:

1. 1823. **Anon.** [Description of the north coast of the Arctic Ocean from the mouth of the Yana to Cape Baranow.] Siberian Messenger, vol. 9, pt. 2, p. 41 (in Russian).
2. 1876. **Argentoff, A.** [Description of the country on the lower Kolyma.] Appendix to the journal "Siberia," vol. 1, p. 337–396 (in Russian).
3. 1887. **Bunge, Dr. Alexander.** Bericht über die im Jana Gebiet im Sommer 1885 ausgeführten Reisen nebst einem Verzeichnisse der daselbst beobachteten oder erkundeten Säugethiere und Vögel. Brief an den bestandigen Sekretär der Akademie über den Gang der von ihr veranstalteten Expedition. Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 73–144.
4. 1907. **Birula, A.** [Sketches of bird life on the north coast of Siberia, with 8 plates and 23 figures in text. Scientific results of the Russian Polar Expedition 1900–1903, conducted by Baron E. Toll. Zoölogical Section, vol. 1, livr. 2.] Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2 (in Russian).
5. 1907. **Buturlin, S.** [Interesting finds.] Venery and Hunting, 1907, p. 92–100 (in Russian).
6. 1907. **Buturlin, S.** [On the Swans of northern Asia.] Ibis, ser. 9, vol. 1, p. 650–652.
7. 1907. **Roznowski, K.** Z Biologii kaczkowatych [Anseriformes] na dalekim polnoce-wichodzie Azyi. Wszechswiat, vol. 26, p. 645–649, 665–669.
8. 1908. **Buturlin, S.** [The Bean Geese.] Our Hunting, no. 11, p. 21–28 (in Russian).
9. 1908. **Buturlin, S. A.** Bemerkungen über die geographische Verbreitung der Vögel im nordöstlichen Sibirien. Journ. f. Ornith., vol. 56, p. 282–294; p. 294, Anmerkungen dazu von H. Schalow.

List of Birds of the Mouth of the Yana.

1. \+ Corvus corax corax Linné. Beyond the limit of trees (Russian Polar Expedition—Birula, 1907, and Lieutenant Kolchak).
2. \+ **Aegiothus** (=**Acanthis**) **hornemanni exilipes** (Coues). To the shores of the Arctic Ocean in north latitude 71° 45′ (Bunge, 1887, sub *Fringilla linaria*).
3. * Plectrophenax nivalis nivalis (Linné). North to latitude 71° (Russian Polar Expedition—Lieutenant Kolchak).
4. * **Calcarius lapponicus lapponicus** (Linné). Swjatoi Noss promontory(Hydrographic Expedition to Arctic Ocean).
5. \+ Motacilla alba ocularis Swinhoe.
6. \+ Saxicola (=Oenanthe) oenanthe oenanthe (Linné). North to latitude 70°.
7. * Nyctea nyctea (Linné). To the shores of the Arctic Ocean in latitude 71° 45′ north (Russian Polar Expedition—Lieutenant Kolchak).
8. * Stercorarius pomarinus (Temminck). To the shores of the Arctic Ocean in latitude 71° 45′ north.
9. \+ Stercorarius crepidatus Banks (=parasiticus Linné). In latitude 67° 30′ north.
10. * Stercorarius longicaudus (Vieillot). To the shores of the Arctic Ocean in latitude 71° 45′ north.
11. err. Larus sp.? (Bunge, sub *Larus marinus* Linné; probably either *Larus argentatus taimyrensis* Buturlin or *Larus schistisagus* Stejneger).
12. * Larus glaucus Brünnich (=hyperboreus Gunnerus). From latitude 71° north to the shores of the Arctic Ocean.
13. * Larus argentatus birulai Sushkin. From latitude 70° 45′ north to the shores of the Arctic Ocean (Russian Polar Expedition—Birula, 1907; Hydrographic Expedition to Arctic Ocean).
14. * Sterna macrura Naumann.
15. * Arenaria interpres (Linné). (Russian Polar Expedition—Birula, 1907.)
16. * Squatarola helvetica (Linné)(=squatarola (Linné)). To the shores of the Arctic Ocean in latitude 71° 45′ north (Hydrographic Expedition to Arctic Ocean—Cape Swjatoi Noss).
17. \+ **Limosa lapponica novae-zealandiae** Gray. (Russian Polar Expedition—Birula, 1907.)
18. \+ **Pavoncella** (=**Philomachus**) **pugnax** (Linné). (Russian Polar Expedition—Birula, 1907.)
19. \+ Gallinago (=Capella) gallinago raddei Buturlin.
20. * Crymophilus fulicarius (Linné). Littoral of the Arctic Ocean (Russian Polar Expedition—Birula, 1907.)
21. \+ Sarcogeranus leucogeranus (Pallas). (Russian Polar Expedition—Birula, 1907.)
22. * Lagopus lagopus (Linné) subsp.? or Lagopus lagopus koreni Thayer and Bangs, or Lagopus lagopus birulai Serebrowsky. (Russian Polar Expedition—Birula, 1907.)
23. * Lagopus rupestris (Gmelin)? or Lagopus mutus pleskei Serebrowsky. (Russian Polar Expedition—Birula, 1907.)
24. * Falco peregrinus peregrinus (Linné).
25. \+ Aesalon (=Falco) aesalon (Tunstall). In latitude 70° 30′ north.
26. * Archibuteo (=Buteo) lagopus pallidus Menzbier.
27. err. **Astur palumbarius** (Linné) (=**Accipiter gentilis** (Linné) subsp.?) (Bunge, 1887.)
?28. \+ Cygnus cygnus cygnus (Linné).
29. * Cygnus bewickii jankowskii Alphéraki. (Buturlin, 1907.)
30. err. Chen hyperboreus hyperboreus (Pallas). (Russian Polar Expedition—Birula, 1907.)
31. * Melanonyx arvensis sibiricus Alphéraki (=Anser fabalis (Latham)). (Bunge, 1887, sub *Anser grandis;* Roznowski, 1907, sub *Anser segetum middendorffii.*)
32. * Melanonyx segetum (=Anser fabalis) serrirostris (Swinhoe). (Bunge, 1887, sub *Anser segetum;* Roznowski, 1907.)

33. * Anser albifrons (Scopoli). (Bunge, 1887; Roznowski, 1907.)
34. + Anser erythropus Linné. (Russian Polar Expedition—Birula, 1907.)
35. * Branta bernicla nigricans (Lawrence). (Russian Polar Expedition—Birula, 1907.)
36. + Dafila (=Anas) acuta (Linné).
?37. + Fuligula (=Nyroca) fuligula (Linné). Near 70° north latitude.
38. * Harelda (=Clangula) glacialis (Linné). (Russian Polar Expedition—Birula, 1907.)
39. + Oidemia nigra americana (Swainson and Richardson).
40. * Heniconetta (=Polysticta) stelleri (Pallas). (Russian Polar Expedition—Birula, 1907.)
41. + **Arctonetta fischeri** (Brandt). (Buturlin, 1908; Russian Polar Expedition—Birula, 1907.)
42. * **Erionetta (=Somateria) spectabilis** (Linné). (Russian Polar Expedition—Birula, 1907.)
43. * Urinator (=Gavia) stellatus (Pontoppidan).
44. * Urinator (=Gavia) arcticus arcticus (Linné). (Russian Polar Expedition—Birula, 1907.)
45. * Urinator (=Gavia) adamsi (Gray). (Russian Polar Expedition—Birula, 1907).

The list of birds from the tundra at the mouth of the Yana published by Professor Palmén contains but 38 species, of which four—*Larus marinus* Linné, *Astur palumbarius palumbarius* (Linné) (=*Accipiter gentilis* (Linné)), *Cygnus cygnus cygnus* (Linné) and *Fuligula* (=*Nyroca*) *fuligula* (Linné)—all recorded by Dr. Bunge, require either that their occurrence in these regions be confirmed, or that their identification be more precisely made. I have added to this number seven species, making my total 45 species. Of this number of species recorded from the mouth of the Yana, 42, or 93.33 per cent, nest there and three, or 6.67 per cent, are of accidental occurrence.

Section XVI. The New Siberian Archipelago.

Schalow, who made the ornithological fauna of the arctic regions his special field of research, published in 1899 the following remarks in a paper entitled "Einige Bemerkungen zur Vogelfauna von Spitzbergen" (Journ. f. Ornith., vol. 47, p. 375, 1899):

> Only two areas in the wide region from Greenland eastward beyond Cape Cheljuskin require revision and a new and thorough investigation. These are the Jan Mayen group of islands and the New Siberian archipelago. For the latter we have only the notes compiled by Palmén in his tables in the conclusion of his review of the birds of the "Vega" in 1887. A thorough investigation of this area is very much to be desired.

This task, the exploration of the New Siberian archipelago, which represented a *pium desidĕrium* for ornithologists, has been accomplished with much success by the Russian Polar Expedition and chiefly through the labors of A. Birula. It is true that some of the smaller islands are still insufficiently explored, but we are nevertheless able to present a list of 49 species noted in the latitudes of this archipelago and we have at our disposal valuable and copious notes concerning the greater part of the species.

The reader will find on a previous page in the account of the route of the Russian Polar Expedition a sufficiently detailed description of the New Siberian archipelago from the ornithologist's point of view.

Literature.

The bibliographic list of **Schalow** (Fauna d. Arktis, 1905) may be completed by the following:

1. 1823. **Anon.** [Description of the coast of the Arctic Ocean from the mouth of the Yana to Cape Baranow.] Siberian Messenger, livr. 9, pt. 2, p. 41 (in Russian).
   Contains a list of sundry species of birds from the New Siberian islands.
2. 1887. **Bunge, Dr. Alex.** Brief an der beständigen Sekretär der Akademie über den Gang der von ihr veranstalteten Expedition nach den Neusibirischen Inseln und dem Jana-Lande. Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 69–144.
3. 1887. **Toll, Baron Eduard.** Fahrten auf den Neusibirischen Inseln. Aufenthalt auf der Insel Kotelny. Beitr. Kenntn. Russ. Reichs, ser. 3, vol. 3, p. 285–322.
4. 1903. **Matiessen, Th.** [Report of the lieutenant of marine Th. Matiessen upon the navigation of the steamer "Sarja" in 1902 and on the return of the crew to Yakutsk. Account of the results of the Russian Polar Expedition, conducted by Baron Toll.] Bull. Acad. Sci. St. Pétersbourg, vol. 18, no. 3, p. 65–88 (in Russian).
5. 1903. **Birula, A.** [Report of the zoölogist A. Bjalinitzki-Birula on his stay and his scientific investigations in the Island of New Siberia in summer of 1902.] Bull. Acad. Sci. St. Pétersbourg, vol. 18, no. 3, p. 91–94 (in Russian).
6. 1904. **Brusneff, M.** [Report of the Chief of the expedition to the archipelago of New Siberia for the rescue of Baron Toll, with a map of the itinerary.] Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 161–194 (in Russian).
7. 1904. **Katin-Jartzeff, V. N.** [In the extreme north]. "God's World," no. 3, March, p. 136 (in Russian).
8. 1905. **Bianchi, Dr. V.** [Exhibition of the eggs and nestlings of the Knot (*Tringa canutus*) procured in the Taimyr Peninsula and in the New Siberian Islands.] Bull. Brit. Ornith. Club, vol. 15, p. 92.
9. 1907. **Birula, A.** [Sketches of bird life on the north coast of Siberia. With 8 plates and 23 figures in text. Scientific results of the Russian Polar Expedition in 1900–1903, conducted by Baron E. Toll. Zoölogical Section, vol. 1, livr. 2.] Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2 (in Russian).
10. 1926. **Serebrowsky, P.** Neue Formen des Morschneehuhnes (*Lagopus lagopus* (L.)). Journ. f. Ornith., vol. 74, p. 511–515.

Of the total number of 49 species of birds recorded from the New Siberian archipelago (nine of which are here for the first time listed), 35 or 71.43 per cent are known to breed there, and 14 or 28.57 per cent are non-breeding or accidental. The occurrence of the species listed as Nos. 39 and 41 requires further confirmation as does also the exact subspecific determination of *Arquatella* (=*Calidris*) *maritima* noted by Birula. I should call the reader's attention to two very peculiar points: (1) that *Branta bernicla nigricans* (Lawrence) breeds in limited numbers in the archipelago, but resorts to the islands in considerable abundance in order to undergo the moult there; (2) that *Harelda* (=*Clangula*) *glacialis* (Linné) frequents the archipelago in great quantity but hitherto it has not been found breeding there.

List of Birds of the

	Semenowski Island	Wassiljefski Island	Stolbowoi Island
1. **Corvus corax corax** Linné	.....	.....	.....
2. **Corone** (= Corvus) **corone levaillanti** (Lesson)	.....	.....	.....
3. Plectrophenax nivalis nivalis (Linné)	.....	.....	.....
4. Calcarius lapponicus lapponicus (Linné)	.....	* (H. E. A. O.)	.....
5. **Motacilla alba ocularis** Swinhoe	.....	.....	.....
6. **Budytes flava borealis** (Sundevall)	.....	.....	.....
7. Saxicola (= Oenanthe) oenanthe oenanthe (Linné)	.....	.....	.....
8. Nyctea nyctea (Linné)	.....	.....	.....
9. **Uria lomvia arra** (Pallas)	.....	.....	* ?
10. Cepphus mandti (Lichtenstein)	.....	.....	*
11. Stercorarius pomarinus (Temminck)	.....	.....	.....
12. Stercorarius crepidatus Banks (= parasiticus Linné)	.....	.....	.....
13. Stercorarius longicaudus Vieillot	.....	*	.....
14. Larus glaucus Brünnich (= hyperboreus Gunnerus)	.....	* (H. E. A. O.)	.....
15. Larus argentatus birulai Sushkin	.....	* (H. E. A. O.)	.....
16. Rissa rissa rissa (Linné) (= tridactyla tridactyla (Linné))	.....	.....	*
17. **Xema sabini** (J. Sabine)	.....	.....	.....
18. Pagophila eburnea (Phipps)	.....	.....	.....
19. Rhodostethia rosea (Macgillivray)	.....	.....	.....
20. Sterna macrura Naumann	.....	.....	.....
21. Arenaria interpres (Linné)	.....	.....	.....
22. Squatarola helvetica (Linné) (= squatarola (Linné))	.....	.....	.....
23. Charadrius dominicus fulvus Gmelin	.....	.....	.....
24. Eudromias (= Charadrius) morinellus (Linné)	.....	+ (H. E. A. O.)	.....
25. Aegialitis (= Charadrius) hiaticula tundrae Lowe	.....	.....	err.
26. Limosa lapponica novae-zealandiae Gray	.....	.....	.....
27. Pavoncella (= Philomachus) pugnax (Linné)	.....	err. (H. E. A. O.)	.....
28. Calidris arenaria Linné (= Crocethia alba (Pallas))	.....	.....	.....
29. **Heteropygia** (= **Calidris**) **maculata** (Vieillot)	.....	.....	.....
30. Limonites (= Calidris) minuta minuta (Leisler)	.....	.....	.....
31. Ancylochilus subarquatus (Güldenstädt) (= Calidris ferruginea (Brünnich))	.....	.....	.....
32. **Arquatella** (= **Calidris**) **maritima** (Gmelin) subsp.	.....	.....	.....
33. Tringa (= Calidris) canutus canutus Linné	.....	.....	.....
34. Phalaropus hyperboreus (Linné) (= lobatus (Linné))	.....	.....	.....
35. Crymophilus fulicarius (Linné)	.....	.....	* (H. E. A. O.)
36. Lagopus lagopus birulai Serebrowsky	* (De Long)	* (H. E. A. O.)	* (R. P. E.)
37. Lagopus rupestris pleskei Serebrowsky?	.....	.....	.....
38. Falco peregrinus griseiventris Brehm	.....	.....	.....
?39. Archibuteo (= Buteo) lagopus pallidus Menzbier	.....	.....	.....
40. **Chen hyperboreus hyperboreus** (Pallas)	.....	.....	.....
?41. Melanonyx arvensis (= Anser fabalis) sibiricus Alphéraki	.....	.....	.....
42. Anser albifrons (Scopoli)	.....	.....	.....

[1] Species not listed by Schalow are printed in bold-face type. In the table: R. P. E. = Russian Polar Expedition; H. E. A. O. = Hydrographic Expedition to the Arctic Ocean,

New Siberian Archipelago.[1]

Great Ljakoff Island	Little Ljakoff Island	Bielkovski Island	Kotelny Island	Faddejefski Island	Island of New Siberia
err. (Birula, 1907)	.....	.....	.....	.....	.....
err. (Birula, 1907)	.....	.....	.....	.....	.....
* (H. E. A. O.)	* (H. E. A. O.)	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
* (R. P. E.; H. E. A. O.)	* (H. E. A. O.)	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
err.	.....	.....	.....	.....	.....
.....	.....	.....	err. (R. P. E.)	.....	.....
+	.....	.....	.....	.....	err.
*	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
.....	.....	* (R. P. E.)	* (R. P. E.)	.....	.....
.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)	.....	.....
*	.....	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
+		.....	.....	+ (R. P. E.)	+ (R. P. E.)
* (R. P. E.)		.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
*	+	* (R. P. E.)	* (R. P. E.)	.....	+ (R. P. E.)
* (R. P. E.)	*	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
.....	.....	* (R. P. E.)	* (R. P. E.)	.....	err. (R. P. E.)
.....	.....	.....	err. (R. P. E.)	.....	.....
.....	.....	.....	err. (R. P. E.)	.....	err. (R. P. E.)
.....	.....	.....	hib. (R. P. E.)	.....	hib. (R. P. E.)
.....	* (H. E. A. O.)	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
* (R. P. E.)	* (R. P. E.)	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
* (R. P. E.; H. E. A. O.)	.....	.....	.....	.....	err.
*	.....	.....	.....	.....	.....
+	.....	.....	.....	.....	.....
+	.....	.....	+	.....	.....
+ (Bunge)[2]	.....	.....	err. (R. P. E.)	.....	.....
.....	.....	.....	err. (R. P. E.)	err. (R. P. E.)	err. (R. P. E.)
*	.....	* (R. P. E.)	* (R. P. E.)	*	* (R. P. E.)
.....	.....	.....	err. (Toll, 1886)	.....	.....
*	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)		* (R. P. E.)
+	.....	.....	+ (R. P. E.)	.....	.....
.....	.....	.....	.....	.....	err. (R. P. E.)
*	.....	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
+ (H. E. A. O.)	.....	.....	.....	.....	+ (R. P. E.)
*	* (R. P. E.; H. E. A. O.)	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
* (R. P. E.)	* (R. P. E.)	* (R. P. E.)	(R. P. E.)	* (R. P. E.)	* (R. P. E.)
+ (R. P. E.)	.....	.....	.....	.....	.....
.....	.....	.....		+ (R. P. E.)	.....
+	.....	.....	.....	.....	.....
err. nid. (R. P. E.)			.....		.....
err. (R. P. E.)			err. (R. P. E.)	.....	.....
+	.....	.....	+ (R. P. E.)	.....	.....

[2] Sub *L. lapponica.*

List of Birds of the

	Semenowski Island	Wassiljefski Island	Stolbowoi Island
43. Branta bernicla nigricans (Lawrence)	.....	.....	.....
44. Nettion (=Anas) formosum (Georgi)	.....	.....	.....
45. Harelda (=Clangula) glacialis (Linné)	.....	.....	.....
46. Heniconetta (=Polysticta) stelleri (Pallas)	.....	.....	.....
47. Arctonetta fischeri (Brandt)	.....	.....	.....
48. Erionetta (=Somateria) spectabilis (Linné)	.....	.....	.....
49. Urinator (=Gavia) stellatus (Pontoppidan)	.....	.....	.....

Section XVII. The De Long Archipelago.

(Bennett, Nowopachenny, General Wilkitzky, Jeanette and Henriette Islands.)

The De Long archipelago comprises five islands, three of which were discovered by the ill-fated "Jeanette" Expedition, and the two others (General Wilkitzky and Nowopachenny Islands) by the Hydrographic Expedition to the Arctic Ocean in 1913 and 1914. The archipelago lies approximately between north latitude 75° 30′ and 77° 42′, and east longitude 148° and 158° 15′. Cape Emma on the south coast of Bennett Island is situated in latitude 76° 38′ north and longitude 148° east of Greenwich and Nowopachenny Island in latitude 76° 10′ north and longitude 153° east. The islands are either wholly or partly of steep rocks covered with snow and ice, and are surrounded for the most part by almost impassable belts of ice. The precipitous slopes of the rocky portions are inhabited, along the edge of the sea, by great numbers of Guillemots and Gulls; and although poor in number of species, bird life is there abundant, as shown by the very large number of individuals.

Literature.

Schalow's (1905) bibliographic list may be completed by the following works:

1. 1883. **De Long, G. W.** The voyage of the Jeanette. London, 8vo, 2 vols.
2. 1888. **Newcomb, R. L.,** Naturalist of the Expedition. Our lost explorers: the narrative of the "Jeanette" Arctic Expedition, as related by the survivors, and in the records and last journals of Lieutenant De Long. Hartford, Conn., 8vo.
   Birds, pp. 182, 183, 197.
3. 1902. **Toll, Ed. von.** [Report of the Chief of the Expedition, the Baron Ed. von Toll, to the Grand Duke Constantin, President of the Academy of Sciences, for the period from January to October 1901. Accounts of the investigations of the Russian Polar Expedition conducted by Baron Toll.] Bull. Acad. Sci. St. Pétersbourg, vol. 16, no. 5, p. 195–206 (in Russian).
4. 1904. **Toll, Ed. von.** [Short report of Baron Ed. von Toll for the period between 7 June and 8 November 1902 with two facsimiles of documents.] Bull. Acad. Sci. St. Pétersbourg, vol. 20, no. 5, p. 158–160 (in Russian).

New Siberian Archipelago—(continued).

Great Ljakoff Island	Little Ljakoff Island	Bielkovski Island	Kotelny Island	Faddejef-ski Island	Island of New Siberia
+ [3]	+ [3]	.....	+ [3]	+ [3]	+ [3]
+	.....	.....	.....	.....	.....
Abundant; not breeding (Bunge; H. E. A. O.)	.....	Abundant; not breeding (R. P. E.)	Abundant; not breeding (R. P. E.)	Abundant; not breeding (R. P. E.)	Abundant; not breeding (R. P. E.)
+ (R. P. E.)	+ (R. P. E.)	.....	+ (R. P. E.)	+ (R. P. E.)	+ (R. P. E.)
err. (Toll, 1886)	.....	.....	.....	err. (R. P. E.)	err. (R. P. E.)
*	* (R. P. E.; H. E. A. O.)	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)
*	.....	.....	* (R. P. E.)	* (R. P. E.)	* (R. P. E.)

[3] Abundant during moulting period (Russian Polar Expedition).

5. 1906. **Kolchak, A.** [The last expedition to Bennett Island undertaken by the Academy of Sciences in search of Baron Toll.] Bull. Russian Geogr. Soc., St. Pétersbourg, vol. 42, p. 487–519 (in Russian).
Ornithological notes, p. 514.
6. 1909. **Toll, Ed. von.** Die russische Polarfahrt der "Sarja" 1900–1902. Aus den hinterlassenen Tagebüchern von. Berlin, 8vo.
7. 1916. **Nasonow, N.** [The zoölogical collections made by the Hydrographic Expedition to the Arctic Ocean on the steamers "Taimyr" and "Waigats" in 1910–1915 and transmitted to the Zoölogical Museum of the Academy of Sciences.] Bull. Acad. Sci. St. Pétersbourg, ser. 6, no. 16, p. 1493–1504.
Report on birds by **V. Bianchi**, p. 1494–1496 (in Russian).

The table shows us: (1) that fifteen species of birds have been reported from the De Long archipelago, of which three are not given in Schalow's list; (2) of this number eight species or 53.33 per cent breed there while seven species or 46.67 per cent have been found in the region either in the open sea or upon different islands.

Section XVIII. The Mouth of the Indigirka.

The section including the mouth of the Indigirka extends along the coast of the Arctic Ocean from the southern end of Chromskaja Bay (in about 71° 40′ north latitude and 145° 12′ east longitude) to the mouth of the Alazeja (approximately 70° 50′ north latitude and 153° 20′ east longitude). The available observations on the ornithological fauna of this section are limited on the one hand to the paper published by Sensinow in 1915 in collaboration with Zitkow, based on observations and collections made in these regions; and on the other hand to native reports gathered by Birula, Buturlin and Roznowski.

The northern boundary of the forest zone in this section reaches even the 71st parallel and only in the eastern part does it begin to fall away toward the mouth of the Kolyma.

List of Birds of

	Bennett Island
1. Plectrophenax nivalis nivalis (Linné)	* (R. P. E.)
2. Uria lomvia arra (Pallas)	* (R. P. E.) [3]
3. Cepphus mandti (Lichtenstein)	* (R. P. E.)
?4. Larus glaucus Brünnich (=hyperboreus Gunnerus) [2]	* (R. P. E.)
?5. Larus argentatus birulai Sushkin	?* (R. P. E.)
6. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné))	* (R. P. E.)
7. Pagophila eburnea (Phipps)	* (Nelson, 1883; R. P. E.)
8. Rhodostethia rosea (Macgillivray)	hib. (De Long, 1883; R. P. E.)
9. Crymophilus fulicarius (Linné)	* (R. P. E.)
10. Lagopus lagopus birulai Serebrowsky	tracks (De Long, 1883)
11. Falco peregrinus griseiventris Brehm	trsv. (R. P. E.)
?12. Haliaëtus (=Haliacëtus) albicilla (Linné)	err. (R. P. E.; Toll, sub *H. leucocephalus*)
13. **Branta bernicla nigricans** (Lawrence)	err. *an* + (R. P. E.; Kolchak, 1906)
14. **Harelda (=Clangula) glacialis** (Linné)	at sea (R. P. E.)
15. **Erionetta (=Somateria) spectabilis** (Linné) [3]	at sea (R. P. E.)

[1] Species not listed by Schalow (Fauna d. Arktis) are printed in bold-face type. R. P. E. = Russian Polar Expedition; H. E. A. O. = Hydrographic Expedition to the Arctic Ocean.

[2] The late Baron Toll recorded five species of Gulls from Bennett Island. Three of these species—*Pagophila eburnea* (Phipps), *Rissa rissa rissa* (Linné) (=*tridactyla tridactyla* (Linné)) and *Rhodostethia rosea* (Macgillivray)—are particularly mentioned; I think I may identify the two others as *Larus glaucus* Brünnich (=*hyperboreus* Gunnerus) and *Larus argentatus birulai* Sushkin.

[3] Kolchak (1906) notes two species of *Somateria* from Bennett Island, basing his statement on the authority of the late Baron Toll. This note contains the following error: Baron Toll in the German text of the letter found by Kolchak, mentions on Bennett Island two species of Guillemots (*Uria*) and in his Russian translation of this document calls these Guillemots *gagi*, that is, Eiders. Kolchak, who took into consideration the Russian text only, was for this reason led into the error indicated.

In this section, too, therefore, the subalpine and the forest zones come very close to the shores of the Arctic Ocean.

Literature.

1. 1905. **Buturlin, S.** [The breeding places of the Rosy Gull.] Venery and Hunting, 1905, nos. 11, 12 (in Russian).
2. 1907. **Buturlin, S.** [Interesting finds.] Venery and Hunting, 1907, p. 92–100 (in Russian).
3. 1907. **Buturlin, S. A.** [On the Swans of northern Asia.] Ibis, ser. 9, vol. 1, p. 650–652.
4. 1907. **Roznowski, K.** Z biologii kaczkowatych [Anseriformes] na dalekim polnoce-wichodzie Azyi. Wszechswiat, vol. 26, p. 645–649, 666–669.
5. 1907. **Birula, A.** [Sketches of bird life on the northern coast of Siberia.] Mém. Acad. Sci. St. Pétersbourg, ser. 8, vol. 18, no. 2 (in Russian).
6. 1908. **Buturlin, S.** [The Bean Geese.] Our Hunting, 1908, no. 11, p. 21–28 (in Russian).
7. 1908. **Buturlin, S. A.** Bean Geese of Asia. Journ. Bombay Nat. Hist. Soc., vol. 18, p. 555–561.
8. 1908. **Buturlin, S. A.** Bemerkungen über die geographischen Verbreitung der Vögel im nordöstlichen Sibirien. Journ. f. Ornith., vol. 56, p. 282–294; p. 294, Anmerkungen dazu von **H. Schalow.**
9. 1908. **Dresser, H. E.** [Exhibition of eggs of *Lampronetta* (*Arctonetta*) *fischeri* Brandt.] Bull. Brit. Ornith. Club, vol. 23, p. 39.

the De Long Archipelago.[1]

Henriette Island	Jeanette Island	Nowopachenny Island	General Wilkitzky Island
.....	.....	.....	.....
* (De Long, 1883)	.....	.....	* (H. E. A. O.)
* (De Long, 1883; Newcomb, 1888)	.....	.....	* (H. E. A. O.)
.....	.....	.....	* (H. E. A. O.)
.....	.....	.....	.....
.....	.....	* (H. E. A. O.)	* (H. E. A. O.)
.....	.....	.....	.....
hib. (De Long, 1883, vicinity)	hib. (De Long, 1883, vicinity)	.....	.....
.....	* (De Long, 1883, vicinity)	* (H. E. A. O.)	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....

10. 1910. **Dresser, H. E.** Eggs of the birds of Europe, including all the species inhabiting the western palaearctic area. London, 4to, 2 vols.

11. 1913. **Sensinow, W.** [A stay at Russkoje Ustje.] "Semlewedenie," 1913, no. 4, p. 7–49 (in Russian).

The author enumerates in this paper several species that are omitted from the scientific memoir published in collaboration with Zitkow; for example: *Strepsilas melanocephalus, Tringa alpina pacifica,* and a Duck which he identifies as *Erismatura* (probably *Harelda* (=*Clangula*) *glacialis* (Linné)). Since a precise identification of the birds collected by Sensinow could have been made only by Zitkow, I think I must regard only the memoir of 1915 as trustworthy and disregard the paper of 1913.

12. 1915. **Zitkow, B., and Sensinow, W.** [On the ornithological fauna of the most northern parts of Siberia.] Journ. Sec. of Zoöl. of the Soc. of Friends Nat. Sci., Anthrop. and Ethnogr., new ser., vol. 3, no. 2, p. 1–19 (in Russian).

List of Birds of the Mouth of the Indigirka.

1. \+ Corvus corax corax Linné.
2. \+ Acgiothus (=Acanthis) sp.?
3. * Plectrophenax nivalis nivalis (Linné).
4. * Calcarius lapponicus lapponicus (Linné).
5. \+ Motacilla alba subsp.?—probably ocularis Swinhoe.
6. * Nyctea nyctea (Linné).
7. \+ Asio accipitrinus (Pallas) (=flammeus Pontoppidan).
8. * Stercorarius pomarinus (Temminck).
9. \+ Stercorarius crepidatus Banks (=parasiticus Linné).
10. * Stercorarius longicaudus (Vieillot).
11. * Larus glaucus Brünnich (=hyperboreus Gunnerus).
12. * Larus argentatus birulai Sushkin. (Russian Polar Expedition—Birula, 1907.)
13. trsv. Rhodostethia rosea (Macgillivray). (Buturlin, 1906; see note in the List of birds of the mouth of the Kolyma.)

14. * Sterna macrura Naumann.
15. * Squatarola helvetica (Linné) (=squatarola (Linné)).
16. + Limosa lapponica novae-zealandiae Gray. (Zitkow and Sensinow, 1915.)
17. + Pavoncella (=Philomachus) pugnax (Linné).
18. ?+ Heteropygia (=Calidris) acuminata (Horsfield). (Buturlin in Dresser, Eggs Birds Europe, p. 821, 1910.)
19. * Limonites (=Calidris) minuta minuta (Leisler). (Buturlin in Dresser, Eggs Birds Europe, p. 697, 1910.)
20. + Gallinago (=Capella) gallinago raddei Buturlin.
21. + Phalaropus hyperboreus (Linné) (=lobatus (Linné)).
22.? err.? trsv. Crymophilus fulicarius (Linné).
23. err. Sarcogeranus leucogeranus (Pallas).
24. * Lagopus lagopus (Linné) subsp.? or Lagopus lagopus koreni Thayer and Bangs?
25. * Falco peregrinus peregrinus Tunstall.
?26. + Haliaëtus (=Haliaëtus) albicilla (Linné).
27. + Archibuteo (=Buteo) lagopus pallidus Menzbier.
28. + Cygnus bewickii jankowskii Alphéraki? (The subspecies is not unquestionably determined.)
29. err. Chen hyperboreus hyperboreus (Pallas).
?30. + Melanonyx arvensis sibiricus Alphéraki (=Anser fabalis (Latham)). (The species is not absolutely identified.)
31. * Anser albifrons (Scopoli). (Buturlin, 1908.)
?32. + Anser erythropus Linné.
33. * Branta bernicla nigricans (Lawrence). (Roznowski, 1907.)
34. + Nettion (=Anas) formosum (Georgi).
35. + Dafila (=Anas) acuta (Linné).
36. * Harelda (=Clangula) glacialis (Linné).
37. + Oidemia nigra americana (Swainson and Richardson).
38. * Heniconetta (=Polysticta) stelleri (Pallas).
39. * Arctonetta fischeri (Brandt). (Buturlin, 1908; Zitkow and Sensinow, 1915.)
40. * Erionetta (=Somateria) spectabilis (Linné).
41. + Merganser (=Mergus) sp.? (Zitkow and Sensinow, 1915.)
42. * Urinator (=Gavia) stellatus (Pontoppidan).
43. * Urinator (=Gavia) arcticus pacificus Lawrence. (Buturlin, 1908.)
44. * Urinator (=Gavia) adamsi (Gray).

Doubtful species.—According to Zitkow and Sensinow (1915) the priest of the village Allaicha, situated at 120 kilometers from the river's mouth, observed a white bird of prey in the region of the Indigirka. It must have been either a Gerfalcon or the *Astur candidissimus* Pallas of Kamchatka, though the latter supposition is the less likely.

Since Professor Palmén, through a lack of special data in his time, was unable to treat separately the fauna of the Indigirka and that of the Kolyma, I may omit a comparison of my lists with his. As at present known, the avifauna of the mouth of the Indigirka comprises 44 species, the occurrence of three of which (Nos. 26, 30 and 32) should be further confirmed. In the case of *Aegiothus* (=*Acanthis*) and *Merganser* (=*Mergus*), the particular species is not exactly identified.

This list shows that of the total number of 44 species recorded for the mouth of the

Indigirka, 40 or 90.9 per cent, have been found nesting and four species or 9.1 per cent are accidental visitors.

Section XIX. The Mouth of the Kolyma.

The section including the regions about the mouth of the Kolyma extends along the shores of the Arctic Ocean from the mouth of the Alazeja (in approximately 70° 50′ north latitude and 153° 20′ east longitude) to the mouth of the River Bolschaja Baranicha, to the west of Chaun Bay (in about 69° 40′ north latitude and 166° 35′ east longitude). The group of Medweshi Islands (Isles of Bears) situated opposite the mouth of the Kolyma, should be included in the same section. The regions belonging to this section have been chiefly explored by Buturlin during his journey in 1905, while one of the Medweshi Islands—namely, Chetyrech Stolbow Island (Island of the Four Posts)—was visited by the Hydrographic Expedition to the Arctic Ocean.

The northern limit of the forest zone cuts the Kolyma River in approximately 69° north latitude, so that the southern portion of the delta is forested while the northern part belongs to the tundra. Between these two zones, the forest zone and the alpine, a rather wide belt covered with thick shrub growth represents the subalpine zone.

Literature.

1. 1861. **Argentow, A.** [The land of the North.] Mem. Russian Geogr. Soc., vol. 2, p. 1–34 (in Russian).
2. 1876. **Argentow, A.** [Sketch of the country of the Lower Kolyma.] Extract from the journal "Siberia," 1876, no. 1, p. 387–396 (in Russian).
3. 1905. **Buturlin, S.** [The breeding places of the Rosy Gull.] Venery and Hunting, 1905, nos. 11, 12, p. 1–24 (in Russian).
4. 1906. **Buturlin, S.** The breeding-grounds of the Rosy Gull. Ibis, ser. 8, vol. 6, p. 131–139, 333–337, 661–666.
5. 1906. **Buturlin, S.** [The game-birds of the Lower Kolyma.] Venery and Hunting, 1906, p. 12–13, 28–29 (in Russian).
6. 1906. **Buturlin, S.** [Communication on the expedition to the Kolyma.] Bull. Russian Geogr. Soc., vol. 42, p. 295–299 (in Russian).
7. 1907. **Buturlin, S.** On the breeding-habits of the Rosy Gull and the Pectoral Sandpiper. (Communicated by H. E. Dresser.) Ibis, ser. 9, vol. 1, p. 570–573, pl. 12.
8. 1907. **Buturlin, S.** [On the Swans of northern Asia.] Ibis, ser. 9, vol. 1, p. 650–652.
9. 1907. **Buturlin, S.** On Bean Geese. Journ. Bombay Nat. Hist. Soc., vol. 17, p. 603–607.
10. 1907. **Buturlin, S.** [Interesting finds.] Venery and Hunting, 1907, p. 92–100 (in Russian).
11. 1907. **Roznowski, K.** Z biologii kaczkowatych [Anseriformes] na dalekim polnoce-wichodzie Azyi. Wszechswiat, vol. 26, p. 645–649, 666–669 (in Polish).
12. 1908. **Buturlin, S.** Bemerkungen über die geographische Verbreitung der Vögel im nordöstlichen Sibirien. Journ. f. Ornith., vol. 56, p. 282–294; p. 294, Anmerkungen dazu von **H. Schalow.**
13. 1908. **Buturlin, S.** [The Bean Geese.] Our Hunting, 1908, no. 11, p. 21–28 (in Russian).
14. 1908. **Buturlin, S.** Bean Geese of Asia. Journ. Bombay Nat. Hist. Soc., vol. 18, p. 555–561.
15. 1910. **Dresser, H. E.** Eggs of the birds of Europe, including all the species inhabiting the western palaearctic area. London, 4to, 2 vols.

16. 1912. **Buturlin, S.** Les places de ponte de la mouette rose. Bull. Soc. Zool. Genève, vol. 1, p. 375–392, pl.
17. 1914. **Thayer, J. E., and Bangs, O.** Notes on the birds and mammals of the arctic coast of East Siberia. Proc. New England Zoöl. Club, vol. 5, p. 1–66, map.
18. 1918. **Riley, J. H.** Annotated catalogue of a collection of birds made by Mr. Copley Amory, Jr., in northeastern Siberia. Proc. U. S. Nat. Mus., vol. 54, p. 607–621.
19. 1927. **Artobolewski, W.** [Contributions to the ornithology of Chuckcheland.] Mem. Kiev Soc. Nat., vol. 27, p. 23–43 (in Russian).

List of Birds of the Mouth of the Kolyma.

1. \+ Corvus corax corax Linné. (Thayer and Bangs, 1914, *sub* Corvus corax sibiricus Taczanowski? Arctic coast.)
2. err. Corone (=Corvus) corone levaillanti (Lesson). (Buturlin, 1906.)
3. \+ Aegiothus (=Acanthis) hornemanni exilipes (Coues). (Buturlin, 1906; Thayer and Bangs, 1914, p. 45—Arctic coast.)
4. * Plectrophenax nivalis nivalis (Linné). (Hydrographic Expedition to the Arctic Ocean—Medweshi Islands; Thayer and Bangs, 1914, p. 46—Cape Bolshoi Baranow.)
5. * Calcarius lapponicus alascensis Ridgway. (Thayer and Bangs, 1914, p. 46—Arctic coast; Riley, 1918, p. 623—Koljuchin Bay.)
6. \+ Saxicola (=Oenanthe) oenanthe oenanthe (Linné). (Thayer and Bangs, 1914, p. 38; Riley, p. 619, Cape Bolshoi Baranow.)
7. \+ Motacilla alba ocularis Swinhoe.
8. \+ Anthus cervinus (Pallas). (Palmén, 1887, p. 272; Thayer and Bangs, 1914, p. 43—Kolyma delta; Cape Bolshoi Baranow.)
9. err. Phylloscopus sp.? (probably *Acanthopneuste* (=*Phylloscopus*) *borealis borealis* (Blasius)).
10. \+ Cotyle (=Riparia) riparia riparia (Linné). (Thayer and Bangs, 1914, p. 36—Kolyma delta, sub *Riparia riparia ijimae* (Lönnberg).)
11. * Nyctea nyctea (Linné). (Thayer and Bangs, 1914, p. 35—coast of Arctic Ocean.)
12. \+ Asio accipitrinus (Pallas) (=flammeus (Pontoppidan)). (Buturlin, *vide* Dresser, 1910).
13. hib. Uria lomvia arra (Pallas). (Palmén, 1887, p. 387—Medweshi Islands.)
14. err. or +? Cepphus mandti (Lichtenstein). (Riley, 1918, p. 611—Cape Bolshoi Baranow.)
15. * Stercorarius pomarinus (Temminck). (Thayer and Bangs, 1914, p. 12; Riley, 1918, p. 612—Cape Bolshoi Baranow.)
16. \+ Stercorarius crepidatus Banks (=parasiticus Linné). (Thayer and Bangs, 1914, p. 12; Riley, 1918, p. 612—Kolyma delta.)
17. * Stercorarius longicaudus (Vieillot). (Thayer and Bangs, 1914, p. 13—Kolyma delta.)
18. * Larus glaucus Brünnich (=hyperboreus Gunnerus). (Thayer and Bangs, 1914, p. 10—coast of Arctic Ocean.)

?19. trsv. Larus glaucescens Naumann. (Buturlin, 1906.)

20. * Larus argentatus vegae Palmén. (Buturlin, 1906; Hydrographic Expedition to Arctic Ocean; Thayer and Bangs, 1914, p. 10—coast of Arctic Ocean.)
21. \+ Larus argentatus birulai Sushkin. (Specimens in our Zoölogical Museum.)
22. \+ Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)). (Palmén, 1887, p. 360—Medweshi Islands.)
23. trsv. Xema sabini (J. Sabine).
24. trsv. Rhodostethia rosea (Macgillivray).[1]

[1] The breeding grounds of the Rosy Gull, *Rhodostethia rosea* (Macgillivray) are situated in the marshes of the subalpine or even of the forest regions of the Kolyma; in the parts of the delta belonging to the tundra the Rosy Gull is apparently not found except in spring when it is proceeding to its breeding grounds and in the autumn when it is returning with its young toward the coasts of the Arctic Ocean.

25. * Sterna macrura Naumann. (Thayer and Bangs, 1914, p. 11—coast of Arctic Ocean.)
26. err. Arenaria interpres (Linné). (Thayer and Bangs, 1914, p. 24—Balagan, sub *Morinella interpres oahuensis* Blokham.)
27. err. Arenaria melanocephala (Vigors).
28. * Squatarola helvetica (Linné) (=squatarola (Linné)). (Thayer and Bangs, 1914, p. 22—coast of Arctic Ocean, sub *Squatarola squatarola hypomelas* (Pallas).)
29. * Charadrius dominicus fulvus (Gmelin). (Thayer and Bangs, 1914, p. 23—coast of Arctic Ocean.)
30. + Eudromias (=Charadrius) morinellus (Linné). (Hydrographic Expedition to the Arctic Ocean—Four Post Island, in the Medweshi Islands.)
31. * Aegialitis (=Charadrius) hiaticula tundrae Lowe. (Thayer and Bangs, 1914, p. 4—coast of Arctic Ocean.)
32. + Limosa lapponica novae-zealandiae Gray. (Thayer and Bangs, 1914, p. 19—Kolyma delta; Riley, 1918, p. 614—Cape Bolshoi Baranow.)
33. * Pavoncella (=Philomachus) pugnax (Linné). (Riley, 1918, p. 615—Kolyma delta.)
34. * Heteropygia (=Calidris) maculata (Vieillot). (Buturlin, 1907, 1908; Thayer and Bangs, 1914, p. 15—mouth of Medweshja River.)
35. +? Heteropygia (=Calidris) acuminata (Horsfield). (Buturlin, 1906; and Dresser, Eggs Birds Europe, p. 821, 1910; Riley, 1918, p. 612—Kolyma delta.)
36. * Limonites (=Calidris) temminckii (Leisler). (Thayer and Bangs, 1914, p. 16—Kolyma delta.)
37. + Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)). (Thayer and Bangs, 1914, p. 18—Cape Bolshoi Baranow.)
38.trsv. Pelidna (=Calidris) alpina sakhalina (Vieillot).
39. + Gallinago (=Capella) gallinago raddei Buturlin.
40. * Phalaropus hyperboreus (Linné) (=lobatus (Linné)). (Riley, 1918, p. 612—Kolyma delta.)
41. * Crymophilus fulicarius (Linné). (Hydrographic Expedition to the Arctic Ocean—Medweshi Islands; Riley, 1918, p. 612—Kolyma delta.)
42. err. Grus (=Megalornis) sp.? (Thayer and Bangs, 1914, p. 25—Cape Bolshoi Baranow.)
43. err. Sareogeranus leucogeranus (Pallas).
44. * Lagopus lagopus (Linné) subsp.? or Lagopus lagopus koreni Thayer and Bangs. ? (Riley, 1918, p. 608—Kolyma delta.)
45. * Lagopus rupestris pleskei Serebrowsky. (Thayer and Bangs, 1914, p. 6—Sucharina.)
46. * Falco peregrinus peregrinus Tunstall. (*Teste* Menzbier, *l.c.*; Thayer and Bangs, 1914, p. 34—Kolyma delta, sub *Falco peregrinus calidus* Latham.)
47. + Haliaëtus (=Haliaeëtus) albicilla (Linné). (Buturlin, 1906.)
?48. err. Haliaëtus (=Haliaeëtus) leucocephalus alascanus Townsend. (Thayer and Bangs, 1914, p. 33—west Arctic Ocean.)
49. + Archibuteo (=Buteo) lagopus pallidus Menzbier. (Thayer and Bangs, 1914, p. 33—Cape Bolshoi Baranow, sub *Archibuteo lagopus lagopus* (Brünnich)).
50. err. Astur palumbarius (Linné) (=Accipiter gentilis (Linné) subsp.?) (Hydrographic Expedition to the Arctic Ocean.)
51. * Cygnus bewickii jankowskii Alphéraki. (Buturlin, 1907; Thayer and Bangs, 1914, p. 31—Kolyma delta, sub *Cygnus bewickii* Yarrell.)
52. err. or trsv. Chen hyperboreus hyperboreus (Pallas).
53. + Melanonyx arvensis (=Anser fabalis (Latham)) sibiricus Alphéraki. (Buturlin, 1908.)
54. + Melanonyx (=Anser) segetum serrirostris (Swinhoe). (Roznowski, 1907; Thayer and Bangs, 1914, p. 29; Riley, 1918, p. 617—Kolyma delta to Chaun Bay.)

55. * Anser albifrons (Scopoli). (Roznowski, 1907; Thayer and Bangs, 1914, p. 29—Kolyma delta.)
56. err. Anser erythropus (Linné).
57. err. Branta bernicla nigricans (Lawrence). (Thayer and Bangs, 1914, p. 30—Cape Bolshoi Baranow.)
58. + Nettion (=Anas) formosum (Georgi). (Thayer and Bangs, 1914, p. 26; Riley, 1918, p. 615—Kolyma delta.)
59. + Dafila (=Anas) acuta (Linné).
60. * Harelda (=Clangula) glacialis (Linné). (Thayer and Bangs, 1914, p. 27; Riley, 1918, p. 615—Kolyma delta.)
?61. + Oidemia fusca stejnegeri (Ridgway).
62. + Oidemia nigra americana (Swainson and Richardson).
63. * Heniconetta (=Polysticta) stelleri (Pallas). (Thayer and Bangs, 1914, p. 27; Riley, 1918, p. 616—coast of Arctic Ocean.)
64. * Arctonetta fischeri (Brandt). (Buturlin, 1906, 1908; Thayer and Bangs, 1914, p. 27—Cape Bolshoi Baranow.)
65. err. Somateria mollissima v-nigrum Gray.
66. * Erionetta (=Somateria) spectabilis (Linné). (Thayer and Bangs, 1914, p. 28—coast of Arctic Ocean.)
67. * Urinator (=Gavia) stellatus (Pontoppidan). (Thayer and Bangs, 1914, p. 7; Riley, 1918, p. 610—Kolyma delta, Cape Bolshoi Baranow.)
68. * Urinator (=Gavia) arcticus pacificus (Lawrence). (Buturlin, 1906, in the littoral zone at a distance of 15 to 20 kilometers from the shores of the Arctic Ocean; Hydrographic Expedition to the Arctic Ocean; Thayer and Bangs, 1914, p. 6—Cape Bolshoi Baranow, sub *Gavia arctica* (Linné).)
69. * Urinator (=Gavia) adamsi (Gray). (Thayer and Bangs, 1914, p. 6; Riley, 1918, p. 610—coast of Arctic Ocean.)
70. + Pedetaithya (=Podiceps) griseigena holboelli (Reinhardt).

Doubtful species.—Argentoff (1876) records for the lower Kolyma region a species of Albatross of large size, but I consider his account too vague to make it possible for me to introduce this bird into my list. For the reasons given in connection with the list of birds of the mouth of the Indigirka I likewise refrain from a comparison of my list of birds from the mouth of the Kolyma with that of Professor Palmén.

The avifauna of this section includes 70 species, of which the occurrence of two—Nos. 19 and 61—requires further confirmation. The form of Mute Ptarmigan (No. 44) must likewise be regarded as insufficiently identified as well as the *Phylloscopus* sp.? (No. 9).

Of the total number of 70 species recorded for the region of the mouth of the Kolyma, 7 or 75.53 per cent have been found to breed there and 17 species or 24.63 per cent occur outside the nesting season, either on passage or during the winter, or else casually.

Section XX. Wrangel and Herald Islands.

Wrangel and Herald Islands constitute two rock masses that rise from the extreme eastern part of the Siberian Arctic Ocean. Wrangel Island is situated in latitude 70° 53′

north and longitude 179° 15′ east, and Herald Island at some distance to the eastward of it. In recent years, the Hydrographic Expedition to the Arctic Ocean succeeded in touching at Wrangel Island and has sent back to us a few specimens of birds from there.

Literature.

The following are in addition to **Schalow,** Fauna Arctica, 1905.

1. 1883. **Rosse, Irving C.** The first landing on Wrangel Island, with some remarks on the northern inhabitants. Journ. Amer. Geogr. Soc., New York, vol. 15, p. 160–204.
2. 1883. **De Long, G. W.** The voyage of the "Jeanette." London, 8vo, 2 vols.
3. 1888. **Newcomb, R. L.,** naturalist of the Expedition. Our lost explorers: the narrative of the "Jeanette" Arctic Expedition, as related by the survivors, and in the records and last journals of Lieutenant De Long. Hartford, Conn., 8vo.
4. 1916. **Nasonow, N.** [Zoölogical collections made by the Hydrographic Expedition to the Arctic Ocean on the steamers "Taimyr" and "Vaigach" in 1910–15 and transmitted to the Zoölogical Museum of the Academy of Sciences.] Bull. Acad. Sci. St. Pétersbourg, ser. 6, no. 16, p. 1493–1504, in Russian.

   Report on the birds by **V. Bianchi,** p. 1494–1496.

*5. 1917. **Muir, John.** The cruise of the Corwin. 8vo, Boston and New York.
6. 1926. **Snyder, L. L.** The birds of Wrangell Island, with special reference to the Crawford collection of 1922. Univ. of Toronto Studies, biol. ser., no. 28, 20 pp.

Schalow's list of birds of Wrangel Island comprises twenty-eight species, of which I feel obliged to strike out three. In the two works by Nelson (Cruise of the Corwin, 1883; Birds of Alaska, 1887) I have been unable to find mention of the occurrence of *Urinator* (=*Gavia*) *arcticus* (Linné) and *Eurynorhynchus pygmaeus* (Linné) on this island. Nelson records *Larus leucopterus* from Herald Island only, but it is omitted from the list of birds of that island prepared by Schalow. Yet even for Herald Island, I have replaced this species by *Larus glaucescens* Naumann, following the opinion expressed by Snyder (1926). I regard *Larus barrovianus* Ridgway as identical with *Larus glaucus* Linné (=*hyperborcus* Gunnerus); concerning *Xema sabini*, Nelson himself (Birds of Alaska, p. 56, 1887) acknowledges the error in identification made in his previous work (Cruise of the Corwin, p. 109, 1883) and expresses the opinion that there can be no doubt that the Gull observed in the latitudes of Wrangel Island was a *Rhodostethia rosea* (Macgillivray) in its first immature plumage; notwithstanding, the species must be reintroduced in the list for Crawford (Snyder, 1926) has succeeded in securing three specimens of this bird. To these 25 species I am adding six species so that the total number of species for Wrangel Island is brought to thirty-one.

Schalow's list (*l.c.*) of the birds of Herald Island includes twenty-three species, from which I feel obliged to eliminate five: viz., *Urinator* (=*Gavia*) *arcticus* (Linné), *Larus barrovianus* Ridgway, and *Eurynorhynchus pygmaeus* (Linné) for the same reasons as for Wrangel Island; *Rissa rissa pollicaris* Stejneger (in my opinion not a distinct subspecies);

List of Birds of Wrangel and Herald Islands.[1]

	Wrangel Island	Herald Island
1. **Corvus corax corax** Linné	err. or +? (De Long, 1883; Hydr. Exp. Arct. Oce.	err. or +? (De Long, 1883)
2. Plectrophenax nivalis nivalis (Linné)	* Nelson, 1887	* Nelson, 1887
3. Calcarius lapponicus alascensis Ridgway	err. or +? (Snyder, 1926).	.....
4. Otomela cristata cristata (Linné)	err.	.....
5. Nyctea nyctea (Linné)	* (Rosse, 1883)	.....
6. Fratercula corniculata (Naumann)	.....	err.
7. Uria lomvia arra (Pallas)	*	*
8. Cepphus mandtii (Lichtenstein)	*	*
9. Pseuduria (=Cepphus) columba (Pallas)	*	*
10. Simorhynchus (=Aëthia) cristatellus (Pallas)	+	+
11. Stercorarius pomarinus (Temminck)	*	*
12. Stercorarius longicaudus (Vieillot)	err. (Schalow, sub *S. parasiticus;* Snyder, 1926)	.....
13. Larus schistisagus Stejneger	.....	err. (Schalow, sub *L. marinus*)
14. Larus glaucus Brünnich (=hyperboreus Gunnerus)	*	*
15. Larus glaucescens Naumann	.....	err. or +? (Schalow sub *L. leucopterus;* Snyder, 1926)
16. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)	*	*
17. Xema sabini (J. Sabine)	+(Nelson, 1883, part; Snyder, 1926)	.....
18. Pagophila eburnea (Phipps)	.....	err.
19. Rhodostethia rosea (Macgillivray)	hib. (Nelson, 1883, part; 1887; Snyder, 1926)	hib. (De Long, 1883)
20. Arenaria interpres (Linné)	+(Snyder, 1926, sub *A. i. oahuensis*)	.....
21. Arenaria melanocephala (Vigors)	err. or +? (Nelson, 1887; Snyder, 1926)	err.
22. Squatarola helvetica (Linné) (=squatarola (Linné))	+(Snyder, 1926, sub *S. s. hypomelas* (Pallas)	.....
?23. Charadrius dominicus fulvus Gmelin	err. or +?	.....
24. Heteropygia (=Calidris) maculata (Vieillot)	err. or +?	.....
25. Tringa (=Calidris) canutus (Linné)	+(Snyder, 1926, sub *C. canutus rogersi* (Mathews))	.....
26. Phalaropus hyperboreus (Linné) (=lobatus (Linné))	* or +?	* or +?
27. Crymophilus fulicarius (Linné)	* Snyder, 1926	*
?28. Branta bernicla nigricans (Lawrence)	? Probably for moulting (Snyder, 1926)	.....
29. **Chen hyperboreus** (Pallas)	+?(Lorne Knight in (Snyder, 1926))	.....
30. **Harelda** (=**Clangula**) **glacialis** (Linné)	At sea (H. E. A. O.)	.....
31. Heniconetta (=Polysticta) stelleri (Pallas)	*	*
32. Somateria mollissima v-nigrum Gray	err. or +? (Snyder, 1926)	.....
33. Erionetta (=Somateria) spectabilis Linné	*	.....
34. Phalacrocorax pelagicus (Pallas)	* (H. E. A. O.)	*
35. Fulmarus glacialis rodgersi Cassin	Oc. Gl. (Nelson, Birds of Alaska, 1887, p. 62).	Oc. Gl. (Nelson, Birds of Alaska, 1887, p. 62).

[1] Species not listed by Schalow (Fauna Arctica, 1905) are printed in bold-face type.

and finally, *Larus marinus* Linné, which should be eliminated from the list because Baird, Brewer and Ridgway (Waterbirds of No. Amer., vol. 2, p. 229, 1884) point out that a specimen of *Larus schistisagus* Stejneger was taken on Herald Island and preserved in alcohol, and that the observations of Nelson on *Larus marinus* Linné and *Larus affinis* Reinhardt really refer to *Larus schistisagus* Stejneger. I am adding, as a species not hitherto listed, *Corvus corax corax* seen in the vicinity of Herald Island by De Long (Jeanette Expedition), which makes my total list 19 species.

Section XXI. North Coast of the Chuckche Peninsula.

The section comprising the north coast of the Chuckche peninsula borders the Arctic Ocean from the mouth of the River Bolschaja Baranicha (approximately in north latitude 69° 40′ and east longitude 166° 35′) to Cape Deshneff (66° 5′ north latitude, 189° 50′ east longitude), the extreme eastern point of the Asiatic continent. These regions have been visited in more recent times by two collectors sent by Mr. J. E. Thayer, one of whom, Captain Kleinschmidt, succeeded in taking an authenticated nest and some young of *Eurynorhynchus pygmaeus* (Linné); while Koren and his companion, Copley Amory, Jr., have explored in part the northern coast of the Chuckche peninsula and in part the Kolyma river-system. Finally, Dr. Savich, surgeon of the steamer "Kolyma," wintered from 18 September 1914 to 30 June 1915 near Cape Severny (Irkaipij). His collection made during this expedition was worked out by Artobolewski and the results were published in the Memoirs of the Kiev Society of Naturalists, vol. 27, p. 28–43, 1927 (in Russian).

The northern boundary of the forest zone drops away to the southward from the beginning of this section at almost a right angle and extends out as far as the northern part of Kamchatka. The entire Chuckche peninsula therefore belongs to the tundra which is here represented by all three sections of the alpine zone. In Professor Palmén's work (1887, p. 253–257) the reader will find a sufficiently detailed description of the region in the vicinity of the "Vega's" winter-quarters near Pitlekaj.

Literature.

In addition to Professor Palmén's work (1887, p. 489) we may cite the following:

1. 1861. **Argentow, ——.** [The land of the North.] Mem. Russ. Geogr. Soc., vol. 2, p. 1–34 (in Russian).
2. 1906. **Buturlin, S.** [The game birds of the lower Kolyma.] Venery and Hunting, 1906, p. 12–13, 28–29 (in Russian).
3. 1907. **Buturlin, S.** [On the Swans of northern Asia.] Ibis, ser. 9, vol. 1, p. 650–652.
4. 1908. **Buturlin, S.** [The Bean Geese.] Our Hunting, 1908, no. 11, p. 21–28 (in Russian).
5. 1911. **Thayer, J. E.** Eggs of the Spoon-bill Sandpiper (*Eurynorhynchus pygmaeus*). Auk, vol. 27, p. 153–155.

6. 1911. **Buturlin, S.** [Discovery of nesting-grounds of *Eurynorhynchus pygmaeus* (Linné)]. Mess. Ornith., p. 112 (in Russian).
7. 1912. **Buturlin, S.** [Breeding grounds of *Eurynorhynchus pygmaeus*.] Mess. Ornith., pp. 3, 54–56 (in Russian).
8. 1912. **Kalinnikow, N.** [Our northeastern regions.] Append. to vol. 34 of the Mem. of Hydrogr., St. Pétersbourg, 8vo (in Russian).
9. 1914. **Thayer, J. E., and Bangs, O.** Notes on the birds and mammals of the arctic coast of East Siberia. Proc. New England Zoöl. Club, vol. 5, p. 1–66, map.
10. 1915. **Gribanowski,** ——. [Memoir on the polar expedition of Mr. Koren into the regions of the Kolyma, of the Yakutsk province.] Bull. of the Yakutsk Sec. of the Russ. Geogr. Soc., vol. 1, p. 114–118 (in Russian).
11. 1915. **Brooks, W. S.** Notes on birds from East Siberia and arctic Alaska. Bull. Mus. Comp. Zoöl., vol. 59, no. 5, p. 361–413.
12. 1917. **Dixon, J.** The home-life of the Baird Sandpiper. Condor, vol. 19, p. 77–84 (ref., Ibis, 1917, p. 622).
13. 1918. **Dixon, J.** The nesting grounds and nesting habits of the Spoon-billed Sandpiper. Auk, vol. 35, p. 387–404 (ref., Ibis, 1919, p. 542).
14. 1918. **Riley, J. H.** Annotated catalogue of a collection of birds made by Mr. Copley Amory, Jr., in northeastern Siberia. Proc. U. S. Nat. Mus., vol. 54, p. 607–626.
15. 1925. **Ushakow, W.** The Ukrania Hunter and Fisherman, 1925, no. 12, p. 18 (in Russian).
16. 1926. **Buturlin, S.** *Chen hyperboreus* von der Chuckchen-Halbinsel. Ornith. Monatsb., vol. 34, p. 34.
17. 1927. **Artobolewski, W.** [Contributions to the ornithology of Chuckcheland.] Mem. Kiev Soc. Nat., vol. 27, p. 28–43 (in Russian).

List of Birds of the North Coast of the Chukche Peninsula.[1]

1. * Corvus corax corax Linné. (Thayer and Bangs, 1914; Riley, 1918—coast Arctic Ocean; Artobolewski, 1927.)
2. \+ ? Corone (=Corvus) corone levaillanti (Lesson). (Thayer and Bangs, 1914—Chaun Bay sub *Corvus orientalis* Eversmann.)
3. * Aegiothus (=Acanthis) hornemanni exilipes (Coues).
4. err. Junco hyemalis (Linné).
5. * Plectrophenax nivalis nivalis (Linné). (Artobolewski, 1927.)
6. * Calcarius lapponicus alascensis Ridgway. (Hydrographic Expedition to the Arctic Ocean—Chaun Bay; Riley, 1918—Koljuchin Bay.)
7. err. Motacilla alba ocularis Swinhoe. (Thayer and Bangs, 1914—coast Arctic Ocean.)
8. err. Budytes flava borealis (Sundevall). (Palmén, 1887, p. 269, sub *Budytes flavus* (Linné); Thayer and Bangs, 1914, p. 41—Koljuchin Bay; Riley, 1918, p. 621—coast Arctic Ocean sub *Budytes flavus plexus* subsp. nov.)
9. err. Anthus cervinus (Pallas). (Thayer and Bangs, 1914—coast Arctic Ocean.)
10. err. Anthus spinoletta japonicus Temminck and Schlegel. (Palmén, 1887, p. 272, sub *Anthus pensilvanicus* (Latham).)
11. err. Seiurus noveboracensis (Gmelin).
12. err. Dendroica coronata (Linné).
13. trsv. Acanthopneuste (=Phylloscopus) borealis borealis (Blasius).
14. \+ Hylocichla minima aliciae Baird.
15. \+ Saxicola (=Oenanthe) oenanthe oenanthe (Linné). (Riley, 1918—Chaun Bay.)

[1] Species not listed by Professor Palmén are printed in bold-face type.

16. + Cyanecula (=Luscinia) svecica robusta Buturlin.
17. * Nyctea nyctea (Linné). (Thayer and Bangs, 1914—coast Arctic Ocean; Artobolewski, 1927.)
18. err. Surnia ulula caparoch (Müller).
19. * Fratercula corniculata (Naumann). (Thayer and Bangs, 1914—Koljuchin Bay.)
20. + Lunda cirrhata Pallas. (Thayer and Bangs, 1914—Koljuchin Bay.)
21. * Uria lomvia arra (Pallas). (Thayer and Bangs, 1914—Koljuchin Island.)
22. + Cepphus mandti (Lichtenstein). (Thayer and Bangs, 1914—Cape Kibera and Cape Severny (Irkaipij); Artobolewski, 1927.)
23. * Pseuduria (=Cepphus) columba (Pallas). (Thayer and Bangs, 1914—from Cape Deshneff to Koljuchin Bay.)
24. err. Ciceronia (=Aëthia) pusilla (Pallas). (Thayer and Bangs, 1914—Cape Iksurin.)
25. err. Simorhynchus (=Aëthia) cristatellus (Pallas). (Thayer and Bangs, 1914—Cape Iksurin.)
26. err. Brachyrhamphus brevirostris (Vigors). (Thayer and Bangs, 1914—west to Cape Yakan.)
27. err. Ombria (=Phaleris) psittacula (Pallas).
28. * Stercorarius pomarinus (Temminck). (Hydrographic Expedition to the Arctic Ocean—Cape Serdze-Kamen; Artobolewski, 1927.)
29. + Stercorarius crepidatus Banks (=parasiticus Linné). (Thayer and Bangs, 1914—coast Arctic Ocean.)
30. * Stercorarius longicaudus (Vieillot). (Artobolewski, 1927.)
31. * Larus glaucus Brünnich (=hyperboreus Gunnerus). (Thayer and Bangs, 1914—coast Arctic Ocean.)
?32. err. Larus glaucescens Naumann.
33. * Larus argentatus vegae Palmén. (Hydrographic Expedition to the Arctic Ocean—Koljuchin Bay; Thayer and Bangs, 1914—Arctic Ocean; Riley, 1918—Chaun Bay; Artobolewski, 1927.)
34. + Larus argentatus birulai Sushkin. (Hydrographic Expedition to the Arctic Ocean—Chaun Bay.)
35. * Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné)). (Thayer and Bangs, 1914—west to Koljuchin Bay, sub *Rissa tridactyla pollicaris* Ridgway.)
?36. err. Xema sabini (J. Sabine).
37. err. litt. hib. Pagophila eburnea (Phipps).
38. err. Rhodostethia rosea (Macgillivray). (Riley, 1918—Chaun Bay.)
39. * Sterna macrura Naumann. (Thayer and Bangs, 1914—shores Arctic Ocean; Riley, 1918—Chaun Bay.)
40. * Arenaria interpres (Linné). (Thayer and Bangs, 1914—Chaun Bay, sub *Morinella interpres oahuensis* (Bloxham); Riley, 1918—Cape Vankarema.)
41. err. or +? **Arenaria melanocephala** Vigors. (Thayer and Bangs, 1914—Chaun Bay.)
42. err. or +? **Squatarola helvetica** (Linné) (= **squatarola** Linné).) (Thayer and Bangs, 1914—Chaun Bay, sub *Squatarola squatarola hypomelas* (Pallas).)
43. * Charadrius dominicus dominicus Müller. (Thayer and Bangs, 1914—Chaun Bay, sub *Pluvialis dominicus fulvus* (Gmelin).)
44. * Eudromias (=Charadrius) morinellus (Linné).
?45. err. Aegialitis (=Charadrius) semipalmatus (Bonaparte).
46. * Aegialitis (=Charadrius) hiaticula tundrae Lowe. (Thayer and Bangs, 1914—shores Arctic Ocean.)
?47. err. Numenius borealis (Forster).
48. err. Macrorhamphus griseus scolopaceus (Say).
49. err. Heteractitis (=Tringa) incanus (Gmelin).

50. err. Tryngites subruficollis (Vieillot).
51. * Eurynorhynchus pygmaeus (Linné). (Thayer, 1911.)
52. * Heteropygia (=Calidris) maculata (Vieillot). (Riley, 1918—Koljuchin Bay.)
53. * Heteropygia (=Calidris) acuminata (Horsfield).
54. err. Limonites (=Calidris) minuta ruficollis (Pallas).
55. err. Limonites (=Calidris) temminckii (Leisler). (Thayer and Bangs, 1914—Chaun Bay.)
56. * Arquatella (=Calidris) maritima couesi Ridgway. (Riley, 1918—Koljuchin Bay.)
?57. err. Arquatella (=Calidris) ptilocnemis (Coues).
58.trsv. Ancylochilus subarquatus (Güldenstädt) (=Calidris ferruginea (Brünnich)).
59. * Pelidna (=Calidris) alpina sakhalina (Vieillot). (Thayer and Bangs, 1914—Cape Serdze Kamen.)
60. err. **Tringa** (=**Calidris**) **canutus** (Linné). (Riley, 1918—Chaun Bay, sub *Canutus canutus rogersi* Mathews.)
61. err. Phalaropus hyperboreus (Linné) (=lobatus (Linné)). (Thayer and Bangs, 1914—Chaun Bay.)
62. * Crymophilus fulicarius (Linné). (Thayer and Bangs, 1914—shores Arctic Ocean; Riley, 1918—Cape Vankarema.)
63. + Grus (=Megalornis) canadensis (Linné). (Thayer and Bangs, 1914—Siebdij Sound, Chaun Bay, sub *Grus* sp.?; Artobolewski, 1927.)
64. * Lagopus lagopus subsp? (Linné). (Artobolewski, 1927.)
?65. + Aesalon (=Falco) aesalon (Tunstall).
66. + **Hierofalco** (=**Falco**) sp.?, probably **H. candicans** (Gmelin). (Thayer and Bangs, 1914—Capes Kibera, Irkaipij, Iksurin; Artobolewski, 1927.)
67. err. **Haliaëtus** (=**Haliaeëtus**) **leucocephalus alascanus** Townsend. (Thayer and Bangs, 1914—coast Arctic Ocean.)
68. * Cygnus sp.? (Cygnus bewickii jankowskii Alphéraki or Cygnus (=Olor) columbianus Ord). (Artobolewski, 1927.)
69. * Chen hyperboreus hyperboreus (Pallas). (Buturlin, 1906, 1926; Artobolewski, 1927.)
70. * **Melanonyx arvensis** (=**Anser fabalis**) **sibiricus** Alphéraki. (Buturlin, 1908.)
71. * **Melanonyx segetum** (=**Anser fabalis**) **serrirostris** (Swinhoe). (Buturlin, 1908; Thayer and Bangs, 1914—Chaun Bay.)
72. err. Anser albifrons (Scopoli). (Artobolewski, 1927.)
73. err. **Anser erythropus** (Linné). (Dresser, 1910, *teste* Buturlin.)
74. * Philacte canagica (Sevastianow). (Thayer and Bangs, 1914—coast Arctic Ocean.)
75. * Branta bernicla nigricans (Lawrence). (Thayer and Bangs, 1914—near East Cape; Artobolewski, 1927.)
76. + Dafila (=Anas) acuta (Linné). (Thayer and Bangs, 1914—Chaun Bay.)
77. + **Nettion** (=Anas) **formosum** (Georgi). (Artobolewski, 1927.)
78. * Harelda (=Clangula) glacialis (Linné). (Thayer and Bangs, 1914; Riley, 1918—coast Arctic Ocean; Artobolewski, 1927.)
79. err. **Fuligula** (=**Nyroca**) **marila mariloides** (Vigors). (Artobolewski, 1927.)
80. * Oidemia fusca stejnegeri (Ridgway). (Nelson, 1883, sub *Melanitta fusca* (Linné); Artobolewski, 1927?)
81. err. Pelionetta (=Oidemia) perspicillata (Linné).
82. * Henieonetta (=Polysticta) stelleri (Pallas). (Thayer and Bangs, 1914—coast Arctic Ocean; Riley, 1918—Cape Severny (Irkaipij).); (Artobolewski, 1927.)
83. * Arctonetta fischeri (Brandt).
84. * Somateria mollissima v-nigrum Gray. (Thayer and Bangs, 1914—coast Arctic Ocean; Riley, 1918, Karpe River; Artobolewski, 1927.)

85. * Erionetta (=Somateria) spectabilis (Linné). (Thayer and Bangs, 1914—Karpe River; Riley, 1918, Chaun Bay; Artobolewski, 1927.)
86. * Phalacrocorax pelagicus (Pallas). (Hydrographic Expedition to the Arctic Ocean; Thayer and Bangs, 1914—Arctic coast to Cape Severny (Irkaipij); Artobolewski, 1927.)
87. err. Oc. Gl. **Fulmarus glacialis rodgersi** (Cassin). Seen by Koren (Thayer and Bangs, 1914—Arctic Ocean.)
88. * Urinator (=Gavia) stellatus (Pontoppidan). (Thayer and Bangs, 1914—Karpe River.)
89. * Urinator (=Gavia) arcticus pacificus (Lawrence). (Thayer and Bangs, 1914—Chaun Bay sub *Gavia arctica* Linné.)
90. * Urinator (=Gavia) adamsi (Gray). (Nelson, 1883, sub *Urinator immer* Brünnich; Thayer and Bangs, 1914—coast Arctic Ocean.)

Professor Palmén's published list of the birds of the north coast of the Chuckehe peninsula, includes 81 species, of which four should be dropped. The "Vega" Expedition did not find there either *Ereunetes pusillus* (Linné) or *Heteropygia* (=*Calidris*) *bairdi* (Coues) and I have been unable to find in the literature any positive record of their presence in these regions. I believe also that *Larus leucopterus* Faber (=*glaucoides* Meyer) must be dropped from the list, for there is no doubt that it does not occur in these countries. Furthermore, since the "Vega" Expedition found only *Urinator* (=*Gavia*) *arcticus pacificus* (Lawrence) in the vicinity of its winter-quarters, I think that Nelson's observations should be referred to this form and that the typical form should for the present be omitted from the lists covering this section. By addition to the remaining species, of those known for the first time from these regions, I make a total of 90, of which Nos. 32, 36, 45, 47, 57, 67, require further confirmation as to their occurrence; while No. 68 is in need of more definite identification.

Of the total number of 90 species recorded from the north coast of the Chuckehe peninsula, 54 species, or 60 per cent, have been found nesting there, while 36, or 40 per cent, occur either outside the breeding season or accidentally.

PART IV.

Summary and Conclusions.

1. *Definition of the term "tundra."*—With the opening of the last chapter of this work, I must first of all define the term "tundra," which I have used throughout the paper, to signify that portion of the globe, the study of whose avifauna has been the subject of my investigation. Its definition will present no difficulty for anyone who has had the opportunity of an acquaintance with the tundra and its bird life on the Kola peninsula. I am extremely glad to have had the opportunity of visiting these regions almost at the very beginning of my ornithological career because I regard Russian Lapland as classic ground for the study of the zones of arctic vegetation and the terrestrial fauna in close dependence upon them. During my stay in the Kola peninsula, unfortunately of very short duration, I obtained such an acquaintance with the arctic vegetative zones as to give me for the rest of my life an absolute conviction of the tenacity with which animals in general and birds in particular are bound to their habitats, that is, to the places that offer them the optimum living conditions. It is easy to secure this conviction while traversing Russian Lapland from south to north by the only road which in 1880, united Kandalaksha with Kola. One travels nearly the entire time in the forest zone (*Regio sylvatica*) and throughout the journey sees only very rarely any species of birds proper to the zone of shrub growth (*Regio subalpina*) or to the alpine zone (*Regio alpina*). But after reaching the subalpine zone, either in the region where (near the station Masselga) the waters flowing to the White Sea are divided from those flowing into the Arctic Ocean, or in approaching the town of Kola, at once one finds himself surrounded by a considerable number of birds belonging to species characteristic of that zone, and for which he had searched in vain while in the forest zone or had found only casually in very limited numbers. A very much more striking difference would be noticed between the different zones of vegetation upon reaching the alpine zone quite bare of shrubs and trees. One would observe this region with its characteristic fauna either along the shores of the Arctic Ocean or upon ascending the mountains, the summits of which are quite bare of forest or bushy vegetation. In both cases one would have made a trip into the "tundra," because the natives of Russian Lapland, whether of Lapp or Russian origin, give to the hills and mountains wooded to their summits, the name *warraka*, while the mountains with bare summits are called *tundra*, derived from the Finnish word *tunturi*. These portions of the arctic lands, called in Eurasia "tundra" and in America "barren grounds," should therefore be regarded as altogether identical with the arctic-alpine zone. This zone includes the islands and archipelagoes

of the Arctic Ocean as well as a strip along the arctic continents of the entire world, and extends in a north-and-south direction from the northern limit of the zone of scrub growth to those latitudes where animal life in general and that of birds in particular, ceases. In the more southerly latitudes it occupies the mountain-tops from the Norwegian Kjölen range on the west, its prolongation in Russian Lalpand, the northern part of the Ural and the Paë-choi range, and a long series of Siberian Alps, eastward to the Stanowoi and Jablonny ranges. At sea level on the Arctic Ocean, we may follow the southern edge of the tundra along the northern boundary of the subalpine zone, that is, we include as belonging to the tundra a strip of greater or less width along the entire Eurasian coasts of the Arctic Ocean. I cannot admit any other boundary of the Eurasian arctic region nor do I find any reason for excluding from this region the northern portions of the continents as Schalow has done in his "Fauna Arctica." Apparently this author has thereby considerably facilitated his task and has thus avoided the analysis, often rather difficult, of the fauna of these portions of the tundra where this fauna is intermixed with representatives of the fauna of the subalpine and forest zones. But had he the slightest reason to ignore the perfectly natural southern limit and to replace it by a southern boundary of ice floes in the Arctic Ocean? In any event, such a boundary of the arctic region must be regarded as not only quite artificial but even inconstant, subject in different years and in different seasons to very considerable fluctuations. I have thought it best to resolve the question of boreal species at the frontier of the arctic area in another way, which seems to me much more regular and logical. In every case where any species characteristic of the subalpine or the forest region has been found only along the northern boundary of the first of these regions, I have left it out of consideration. But whenever one of these species is recorded in some part of the Eurasian tundra, whether more or less distant from its southern limit, I have included it in my lists. As examples, I may cite the following cases: I have omitted *Cynchramus* (= *Emberiza*) *schoeniclus schoeniclus* (Linné) recorded only from the northern limit of the subalpine zone of the Kanin peninsula and of the mouth of the Yenisei, but I have included in my lists *Cynchramus* (= *Emberiza*) *schoeniclus polaris* (Middendorff) recorded in high latitudes from the tundra of Eastern Taimyr; likewise I have left out *Anthus gustavi* Swinhoe recorded some distance to the south of the mouths of the Pechora and the Yenisei but never from the tundra, properly speaking, but I have taken into consideration *Anthus trivialis hodgsoni* Richmond found in the same high latitudes of Eastern Taimyr.

2. *Origin and history of the tundra; its botanical subdivision.*—In the next place I feel that I should explain the origin of the tundra and the reasons for the absence in this region of a sturdier vegetation in the shape of bushes and trees. If we take a glance at

Loukaschewicz's map (M. Menzbier, [The zoölogical districts of Turkestan and the probable origin of its fauna,] Ann. Soc. Encour. Exper. Sci. and its Applic. of the name of Chr. Ledentzoff, p. 128) which shows the distribution of glaciers in the Eurasian region toward the end of the Ice Age, we shall see that at the height of this period, the glaciers covered completely the northern part of Eurasia, that is, Great Britain, Scandinavia, northern Germany, the northern and central parts of European Russia and a band of varying width along the Siberian mainland. All these countries as well as the islands and archipelagoes of the Arctic Ocean, belonged, according to Wahlenberg's terminology to the upper glacial portion of the alpine zone (*Regio alpina γ glacialis*). I hesitate to give illustrations of this upper zone, since the descriptions of polar countries, especially of Greenland and Spitzbergen, abound in illustrations of arctic glaciers. But since the time of the gradual change in the eccentricity of the earth's orbit and the adoption by the earth's axis of a position more and more favorable for the northern hemisphere, this immense glacier, following the amelioration, however slight, of the climatic conditions, must have begun to melt, to lose a portion of the ground covered, and to approach little by little to its present area (on the summits of the mountain chains of the Eurasian continent, a portion of Spitzbergen, the Franz Josef archipelago, the center of the northern island of Nova Zembla, Emperor Nicholas II Land). The presence in the northeastern Atlantic of a refrigerating agent of such great proportions as this glacier, must inevitably have created an interchange of warm and of cold waters, in order to overcome too great a difference in temperature between the waters from the tropical parts of this ocean on the one hand and those from its northeastern part on the other. There would thus be a warm superficial current flowing from the equatorial regions toward the northeast and a cold deep current flowing in a southwesterly direction to correspond. But as the glaciers coming down from the Kjölen range supplied the northeastern part of the Atlantic with a considerable amount of detached ice-floes and icebergs, and the icy water melted from the same glaciers was discharged into the same portions of the ocean, the cooling agent of the northeast portion of the Atlantic Ocean would have disappeared only very gradually, maintaining the low temperatures of the waters of this region and producing a reinforcement of the warm current so that the latter only by slow degrees attained the great dimensions of the current bearing the name of the Gulf Stream. The flow of warm waters became so great that the current not only warmed the seas that washed the Norwegian coasts but it even extended its course to the northward and sent its surplus of warm water in part toward the west coast of Spitzbergen and in part to the Barenz Sea, passing first along the coasts of Russian Lapland and turning thence toward the western shores of Nova Zembla. The combination of the two factors, namely, the more favorable position of the earth's axis for the northern hemisphere on the one hand

and the influence of the strong current of warm waters on the other, gradually brought about a diminution of the glaciers, and a reduction in the land area they had occupied. The rocky strata uncovered by the glaciers and polished by their forward movement, remained for a considerable time sterile, and could not at first offer favorable living conditions for plants; they had to pass through a long series of changes before they could attain a covering of some sort of alpine or dwarfed vegetation. They had first to go through the slow process of erosion and to become covered with a sufficient layer of detritus scattered on which the first alpine plants could secure a foothold. But the latter could not become vigorous and develop readily because their roots met with a very serious obstacle, notably the presence of permanent ice at a minimum depth from the surface of the soil. We no longer doubt that the development of the tundra vegetation is prevented first of all by this permanent ice and not by the low air temperatures or the cold winds, because in every case where the soil is sufficiently drained and stagnant water is found at a more considerable depth from the surface, we find the conditions more favorable and note that not only does the alpine flora become richer and more varied but bushes or even trees begin to appear. The borders of northern brooks, rivers and streams are very instructive on this point; the slopes of their banks are evidently better drained than the flat ground near by and the position of the superficial strata of these banks presents no obstacles to the growth and vertical penetration of the roots. This is why the northern streams at middle latitudes are bordered with bushes or trees that push up along the valleys as tongues into the bare tundra. Those parts of the tundra that have only in relatively recent times become free from glaciers and are covered with a very meager vegetation, represent in the old terminology of Wahlenberg, the *Regio alpina β camporum nudorum*, the arctic tundra of Gorodkoff[1] and the bare or patchy tundra of Professor Tanfiljeff.[2] The last-named author describes the formation of this vegetative zone in the following words:

> The sandy or clayey soil, as soon as it becomes exposed to the winds, does not become covered with snow in the winter, according to the statements of the Samoyedes. For this reason the soil becomes much dried out and covered with cracks which surround flakes of varying size, sometimes as big as a saucer or a plate, sometimes as big as a cart wheel. These flakes are quite bare of vegetation and the alpine plants push up only along the cracks between the flakes. These plants are in the first place creeping bushes of *Ledum palustre*, *Vaccinium uliginosum*, *Betula nana*, *Rubus arcticus*, *Dryas octopetala*, *Empetrum nigrum*, *Arctostaphylos alpinus* and *Salix herbacea*, accompanied by a small quantity of *Polytrichum strictum*. The vegetation becomes more and more luxuriant only after a considerable space of time, during which the annual débris from the original meager vegetation has formed a thicker layer of humus. The amount of plants annually increases and the dwarf bushes become larger.

[1] Gorodkoff, B. [Attempt at a subdivision of the West-Siberian plain into botanico-geographical regions. With a map of the botanico-geographical regions.] Ed. of the Museum of the Tomsk Gov., p. 50, 1916 (in Russian).

[2] Tanfiljeff, G. [The borders of the forests in polar Russia.] Odessa, 1911, p. 30 (in Russian).

We now find ourselves in the lower zone of the alpine region (following Wahlenberg's classification) (*Regio alpina a salicum*), in the typical tundra of Gorodkoff (*l.c.*, p. 47) and in the tundra with clumps of turf or in the undulated tundra of Professor Tanfiljeff (*l.c.*, pp. 32, 35). The latter's subdivision of these parts of the tundra may also be admitted from an ornithological point of view because his two different tundra habitats are occupied by different species of birds during the breeding season, and, as it seems to me, these habitats or stations are of a totally different origin. The tundra with clumps of turf requires, according to Professor Tanfiljeff, that the mineral subsoil should be covered by a layer of turf of a thickness of one or two feet; the surface of these areas is compact, not marshy, and covered with inconspicuous clumps composed of *Polytrichum* and *Festuca ovina;* the vegetation consists of *Empetrum nigrum, Salix reticulata glauca,* and *Betula nana,* and in some places presents a silvery appearance, due to the *Cladonia rangiferina* and *Stereocaulon paschale.* These parts of the tundra evidently represent only the older areas of the patchy or spotted tundra of the same author and have the same origin; they require a mineral subsoil, pebbly and less saturated with moisture. The undulated tundra is covered with great beds and clumps of turf; its flora is chiefly composed of lichens (mainly *Cladonia rangiferina*) and mosses (*Sphagnum* and *Polytrichum*); the thick beds of these plants are covered with a carpeting of *Rubus chamaemorus* and dotted with bushes of *Betula nana, Vaccinium uliginosum, Empetrum nigrum* and *Andromeda polifolia.* These parts of the tundra are evidently much more humid and have a different origin. The mosses probably at first occupied only the borders of the pools of water formed by the melting of the snow and the glaciers, and have little by little completely invaded these waters, covering them with a layer first of moss, then of turf of gradually increasing thickness. Such mossy bogs, sometimes supporting stunted pine trees, are scattered over a wide extent of the forest region. They are inhabited by a series of species of northern birds, which, being confined to a habitat of moss-covered bogs, occupy similar stations in the vicinity of the tundra although neither these stations nor their inhabitants belong strictly to the flora and fauna of the tundra.

The excellent photographs brought back by the Russian Polar Expedition, permit me to offer the reader a series of illustrations of the tundra of Western Taimyr and the islands of New Siberia. With the help of these latter one may not only gain a general idea of the appearance of these high latitudes but may also be convinced that the plants do no make a uniform carpeting, but grow in little clumps leaving the soil in part quite without vegetation. (See Plates: 29, fig. 2—General view of the tundra from Kuzkin Island opposite Port Dickson, mouth of the Yenisei; 29, fig. 1—View of the tundra on the shore of Walter Bay, Western Taimyr; 30, fig. 1—Clump of *Saxifraga caespitosa,* Walter Bay, Western Taimyr; 31, fig. 1—Tundra vegetation, *Papaver nudicaule, Potentilla, Salix,* at

Nerpalach, Kotelny Island; 31, fig. 2—*Papaver nudicaule* at New Siberia; 30, fig. 2—Clump of *Oxyria digyna* in New Siberia; 32, fig. 1—Portion of the tundra covered with *Potentilla sp.?*, *Luzula sp.?* and *Lloydia* on the Island of New Siberia.)

It only remains to say a few words on the zone of bushes or shrub (*Regio subalpina*), which as we have seen represents the southern limit of the tundra. This zone consists in its upper portions of thickets of willow (*Salix*) and of birch (*Betula nana*), and in its lower portions of thickets of white birch (*Betula alba*), alder (*Alnus glutinosa*) (or their representatives in the Siberian flora) and in the latter also, of *Alnaster*. This zone is relatively poorly marked and occupies a somewhat narrow band at varying distances from the shores of the Arctic Ocean. Its width in the latitudes of Kola Fjord does not exceed thirty kilometers. From the published literature I am unable to define either the differences in width of this zone or its distance from the seacoasts in the different parts of the Eurasian continent. I have found it possible to determine only that in the middle and eastern parts of northern Siberia (mouths of the Lena, the Yana, the Indigirka and the Kolyma) the subalpine zone occasionally reaches the coasts of the Arctic Ocean, particularly in the form of prominences or tongues along the banks of rivers that empty into this ocean. This condition is likewise found in Russian Lapland, a fact that decided me to illustrate by a small map (see the List of Birds of the Tundra of the Kola Peninsula) the approximate distribution of the vegetative zones of the Kola peninsula. For this reason the subalpine zone is only approximately given on the map accompanying that work; in some places it is based upon well-determined points, but its limits as shown cannot be regarded as exact.

A beautiful photograph (Pl. 32, fig. 2) shows us the subalpine zone on the lower course of the Charaulach River, in the latitudes of the Lena delta.

3. *Is there any reason for raising the Arctic Zone to the rank of a special zoögraphic region?*—The definition of the tundra as the alpine zone of the holarctic region gives us the opportunity of unhesitatingly denying the need for raising the arctic zone to the rank of a distinct zoögraphic region of the first order. The immense extent occupied by the tundra, first of all, has influenced many well-known zoölogists (Wagner, Schmarda, Agassiz, Allen, Heilprin, Reichenow, Brauer, C. Hart Merriam, Möbius, Lydekker, Matschie) to support this view; among the ornithologists it was Reichenow particularly who insisted most energetically on this point. But other naturalists, not less distinguished (Sclater, Kobelt, von Martens, Jacobi), strongly opposed the need for this, basing their negative opinion upon arguments not less convincing. The detailed study of the avifauna of the Eurasian portion of the holarctic region has convinced me as well of the inadequacy of the reasons advanced for giving to the arctic zone the rank of an independent zoögraphic region. If in the case of mammals we find ourselves still con-

fronted by a series of very distinct species wholly characteristic of the arctic zone (such as *Ovibos, Odobenus, Monodon*), for birds there is no such parallel. Reichenow's list of the genera of birds characteristic of his independent Arctic Region, contains the names of the following: *Urinator* (=*Gavia*), *Xema, Rhodostethia, Pagophila, Rissa, Phalaropus, Somateria, Nyctea, Plectrophenax* and *Aegiothus* (=*Acanthis*), and seems to me insufficient to uphold his deductions. Of this number, the genus *Aegiothus* (=*Acanthis*) in no wise belongs to the arctic fauna, for its representatives nest only on the southern boundary of the tundra region and not in the tundra itself. The genera *Phalaropus* and *Somateria*, although unquestionably arctic, live not only in the arctic regions, but also at times in the more southern portions of the boreal zone, for example, they are found breeding on the coasts of the Baltic, south of the Gulf of Finland, that is, along the southern limit reached by glaciers in these regions at the climax of the glacial period. One Eurasian species of the genus *Urinator*—*Urinator* (=*Gavia*) *arcticus arcticus* (Linné)—should be regarded not as an arctic but as a decidedly boreal species, while a second—*Urinator* (=*Gavia*) *stellatus* (Pontoppidan)—is widely distributed not only in the tundra zone but in the forest zone as well. In regard to the Gulls of the genera *Xema, Rhodostethia, Pagophila* and *Rissa*, which unquestionably represent very striking forms of the arctic fauna, it cannot be denied that they are closely related to the cosmopolitan genus *Larus*. Considering that three of these genera include but a single species each, and the fourth contains but two species, I incline to regard them as merely subgenera of *Larus*. But in any event I give much more importance to the undeniable fact that the entire arctic portion of the continents of the globe corresponds to the arctic-alpine zone and for this reason can make no claim to recognition as a separate zoögraphic region. What should we make of all the mountain ranges scattered in different parts of the forest zone, with their summits reaching into the alpine zone? The absence of some striking difference in their flora and fauna in comparison with the typical tundra would in no wise warrant us in classifying them otherwise than as part of the tundra.

4. *Analysis of the avifauna of the Eurasian tundra.*—In the solution of the previous question, I have expressed myself with full conviction in the negative, but I am fully in accord with those naturalists who regard it impossible to separate the palaearctic from the nearctic region and recognize but a single, holarctic region. The study of the Eurasian tundra fauna has quite convinced me of the correctness of this point of view. Bering Strait, as we shall see farther on, does not in any case represent a zoögeographic boundary and offers no excuse for separating the arctic portions of the Old World from those of the New. If, nevertheless, in the text of this work, I have made use of the expressions "Eurasian part" and "Nearctic part," I beg the reader to regard these expressions as altogether geographic, having no relation to the zoögraphy nor implying in any

case subdivisions of the holarctic region. The latter, in its Europeo-Asiatic part, may be subdivided, according to its avifauna, into a series of provinces the faunas of which grade little by little into one another and present no striking differences in the fauna of their eastern portions as compared with that of the western portions of the American continent.

A. Circumpolar Species.

We should first of all analyze the list of circumpolar arctic and boreal birds on the basis of the table representing the lists published by Professor Palmén in 1887 and by Schalow in 1905 on the one hand, and that by the author of the present work.

Professor Palmén's list of circumpolar arctic birds is prepared with a full knowledge of the subject and although dating from the year 1887, may be regarded as accurate with the following insignificant changes: (1) our present knowledge of the geographic distribution of *Larus leucopterus* Faber (=*glaucoides* Meyer) and of *Aegialitis* (=*Charadrius*) *hiaticula hiaticula* (Linné) confirms the doubts that Professor Palmén expressed with regard to these species which he then included with reservation in his list of arctic circumpolar birds. I therefore prefer to eliminate them from the list. (2) *Corvus corax* Linné, *Calcarius lapponicus* (Linné), *Otocorys* (=*Eremophila*) *alpestris* (Linné), *Saxicola* (=*Oenanthe*) *oenanthe* (Linné) and *Uria lomvia* (Linné) present subspecific variations in the holarctic region and can no longer be regarded as circumpolar species. (3) *Urinator* (=*Gavia*) *immer* (Brünnich) is completely absent as a breeding bird from the Eurasian portion of the holarctic region and only appears in limited numbers in its western latitudes to winter. (4) *Urinator* (=*Gavia*) *arcticus arcticus* (Linné) is a boreal, not an arctic species and cannot be included among the list of circumpolar birds for in America it is probably in large part replaced by *Urinator* (=*Gavia*) *arcticus pacificus* (Lawrence). (5) I hold that we must eliminate from the list of circumpolar arctic birds *Rhodostethia rosea* (Macgillivray) which in accordance with our present knowledge of its relatively restricted breeding grounds should be regarded as a Siberian species, not a circumpolar one, though making during the non-breeding season, extensive annual migrations in the course of which it has been recorded from a number of localities in the arctic zone throughout the holarctic region. (6) *Heniconetta* (=*Polysticta*) *stelleri* (Pallas) and *Histrionicus histrionicus* (Linné) are during the breeding season inhabitants of the subalpine zone.

In brief, I believe that eleven species should be eliminated from Professor Palmén's list, and four species added, in accordance with more recent observations (in some cases still insufficiently established), namely: *Aegiothus* (=*Acanthis*) *hornemanni exilipes* (Coues), *Hierofalco* (=*Falco*) *islandus* (Brünnich), *Hierofalco* (=*Falco*) *candicans* (Gmelin), *Anser albifrons* (Scopoli) (uniting the two forms). After these changes we have therefore 26 circumpolar arctic species admitted to my list.

Circumpolar Arctic Species inhabiting the Eurasian Tundra.

Palmén, 1887	Schalow, 1905	Pleske, 1928
1. Corvus corax Linné	———	———
———	———	1. Aegiothus (=Acanthis) hornemanni exilipes (Coues)
2. Plectrophanes nivalis (Linné)	1. Passerina nivalis nivalis	2. Plectrophenax nivalis nivalis (Linné)
3. Centrophanes lapponicus (Linné)	?2. Calcarius lapponicus	
4. Otocorys alpestris (Linné)	———	———
5. Saxicola oenanthe (Linné)	———	———
6. Nyctea scandiaca (Linné)	3. Nyctea nyctea	3. Nyctea nyctea (Linné)
7. Uria arra (Pallas)	4. Uria lomvia	———
8. Uria grylle Linné, var. mandtii Lichtenstein	5. Cepphus mandtii	4. Cepphus mandti (Lichtenstein)
9. Lestris pomatorhina Temminck	6. Stercorarius pomarina	5. Stercorarius pomarinus (Temminck)
10. Lestris crepidatus Banks	7. Stercorarius parasitica	6. Stercorarius crepidatus Banks (=parasiticus Linné)
11. Lestris longicaudus Brisson	8. Stercorarius cepphus	7. Stercorarius longicaudus (Vieillot)
12. Larus glaucus Linné	9. Larus glaucus	8. Larus glaucus Brünnich (=hyperboreus Gunnerus)
13. (Larus leucopterus Faber: nearctic really and not polar)	———	———
14. Rissa tridactyla (Linné) (with its variety)	10. Rissa rissa rissa	9. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné))
15. Xema sabinei Leach	11. Xema sabinii	10. Xema sabini (J. Sabine)
16. Rhodostethia rosea (Macgillivray)	12. Rhodostethia rosea	———
17. Pagophila eburnea (Phipps)	13. Gavia alba	11. Pagophila eburnea (Phipps)
18. Sterna paradisea Brünnich	14. Sterna macrura	12. Sterna macrura Naumann
19. Strepsilas interpres (Linné)	15. Arenaria interpres	13. Arenaria interpres (Linné)
20. Squatarola helvetica (Linné)	———	14. Squatarola helvetica (Linné) (=squatarola (Linné))
21. Aegialitis hiaticula (Linné)	———	———
22. Calidris arenaria (Linné)	16. Calidris arenaria	15. Calidris arenaria (Linné) (=Crocethia alba (Pallas))
23. Tringa canutus Linné	———	16. Tringa (=Calidris) canutus Linné
24. Phalaropus lobatus (Linné)	———	17. Phalaropus hyperboreus (Linné) (=lobatus (Linné))
25. Phalaropus fulicarius (Linné)	17. Crymophilus fulicarius	18. Crymophilus fulicarius (Linné)[1]
26. (?Lagopus rupestris (Gmelin))	———	19. Lagopus rupestris (Gmelin)
———	———	20. Hierofalco (=Falco) islandus (Brünnich)
———	———	21. Hierofalco (=Falco) candicans (Gmelin)
———	———	22. Anser albifrons (Scopoli)[2]
27. Harelda glacialis (Linné)	18. Clangula hyemalis	23. Harelda (=Clangula) glacialis (Linné)
28. Heniconetta stelleri (Pallas)	———	———
29. Somateria spectabilis (Linné)	19. Somateria spectabilis	24. Erionetta (=Somateria) spectabilis (Linné)
30. Colymbus septentrionalis Linné	20. Urinator lumme	25. Urinator (=Gavia) stellatus (Pontoppidan)
31. Colymbus arcticus Linné	———	———
?32. Colymbus torquatus Brünnich	———	———
33. Colymbus adamsi Gray	———	26. Urinator (=Gavia) adamsi (Gray)

[1] According to Thayer and Bangs (1914) there are no tangible differences between American and North Siberian specimens of *Crymophilus fulicarius* (Linné); for my part I have undertaken a careful comparison of our East Siberian specimens with those from western Siberia and European Russia and have not detected any difference between them except seasonal changes in the vivacity of coloration and the breadth of the edges of the feathers of the back. For these reasons I prefer to treat this species as a circumpolar bird.

[2] Regarding *Anser albifrons albifrons* (Scopoli) and *Anser albifrons gambeli* Hartlaub as one species.

As regards Schalow's list, it should be looked upon as the inevitable result of the unfortunate idea of disregarding the arctic zone of the mainland in treating of the arctic avifauna. For this reason alone Schalow has omitted from his list the following species that are unquestionably circumpolar arctic birds: *Squatarola helvetica* (Linné) (= *squatarola* (Linné)), *Tringa* (=*Calidris*) *canutus canutus* Linné, *Phalaropus hyperboreus* (Linné) (=*lobatus* (Linné)). As to the first of these species, the author writes (1905, p. 205) as follows: "*Squatarola helvetica* ist ein circumpolarer Vogel," and yet he hesitates to include it among the circumpolar species because it nests in only a restricted part of the islands of the Arctic Ocean! I have found it very difficult to orient myself in this author's generalizations concerning the geographic distribution of a considerable number of species, for they seem to me very peculiar and very little in accord with the real distributional limits of the birds in question. But since I became convinced that all these conclusions were the inevitable result of his unfortunate scheme of treating the geographic distribution of arctic birds without taking into consideration the arctic zone of the continents, his entire viewpoint at once became clear. He could have confined himself to listing the records of arctic birds in the different islands and archipelagoes of the Arctic Ocean, but he should have abstained altogether from drawing conclusions as to the general distribution of the species, based on these data only, in view of the almost certain risk of making mistakes. As a very instructive illustration of the result of such a procedure, I will merely quote a few lines on the geographic distribution of *Urinator* (=*Gavia*) *arcticus arcticus* (Linné) (*l. c.*, p. 118), where he says: "Im Westen geht er von der asiatischen Küste bis in die Gebiete von Waigatsch und Kolguew. Auf Spitzbergen und der Bären-Insel fehlt die Art gleichfalls. Erst über diese Gebiete nach Osten hinaus tritt sie auf. Von Kolguew ostwärts beginnt das eigentliche Verbreitungsgebiet des schwarzkehligen Tauchers." But what of the very considerable number of these birds that breed in the forest zone throughout the boreal part of Europe as far as Scandinavia and Lapland, and obviously are not less numerous in these regions than to the east of Kolguev Island?

I should make the following explanations as to my own list of circumpolar arctic birds. Certain species regarded as circumpolar do not inhabit the arctic lands of the entire globe but only their greater part. As an example I may first of all cite *Lagopus rupestris* (Gmelin) which breeds from the northern Ural across the whole of arctic Siberia and in America, but is absent from Norway and Russian Lapland, where it is replaced by *Lagopus mutus mutus* (Montin), which has probably reached these regions (the last to be freed from the glacier) from the south and constitutes two distinct subspecies though very close to the races of the Alps and of Scotland. Again, *Urinator* (=*Gavia*) *adamsi* (Gray), which has not hitherto been found nesting in Russian Lapland, inhabits the coasts of

Conditions of Occurrence of Arctic Circum-

	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolsheesmel-skaja tundra	Vaigach Island	Nova Zembla
Section	I	II	III	IV	V	VI	VII	a VIII b
1. Aegiothus (=Acanthis) hornemanni exilipes (Coues)	—	—	*	?+	?err.	+	?+?	err. / —
2. Plectrophenax nivalis nivalis (Linné)	*	*	*	*	*	*	*	* / *
3. Nyctea nyctea (Linné)	+	—	*	+	+	*	+	* / *
4. Cepphus mandti (Lichtenstein)	*	*	hib.	—	—	—	*	* / *
5. Stercorarius pomarinus (Temminck)	+	+	+	+	+	+	+	+ / +
6. Stercorarius crepidatus Banks (=parasiticus (Linné))	*	+	*	+	*	*	*	* / *
7. Stercorarius longicaudus (Vieillot)	+	err.	+	*	+	*	*	+ / +
8. Larus glaucus Brünnich (=hyperboreus Gunnerus)	*	*	*	*	*	*	*	* / *
9. Rissa rissa rissa (Linné) (=tridactyla tridactyla (Linné))	*	*	*	hib.	hib.	M. K.	*	* / *
10. Xema sabini (J. Sabine)	+	—	hib.	—	+	—	—	— / —
11. Pagophila eburnea (Phipps)	*	trsv.	hib.	hib.	hib.	rr. hib.	hib.	* / *
12. Sterna macrura Naumann	*	*	*	*	+	*	*	* / *
13. Arenaria interpres (Linné)	+	+	*	—	*	*	+	* / *
14. Squatarola helvetica (Linné) (=squatarola (Linné))	—	—	err.	+	*	*	—	err. / —
15. Calidris arenaria (Linné) (=Crocethia alba (Pallas))	+	—	err.	—	trsv.	trsv.	trsv.	?err. or + / —
16. Tringa (=Calidris) canutus canutus Linné	err.	—	trsv.	—	—	—	—	— / —
17. Phalaropus hyperboreus (Linné) (=lobatus (Linné))	+	—	*	*	*	*	*	* / —
18. Crymophilus fulicarius (Linné)	*	+	hib.	—	+?	—	+?	* / —
19. Lagopus rupestris (Gmelin) ?	—	—	—	—	—	—	?+?	? / —
20. Hierofalco (=Falco) islandus (Brünnich)	err. or + ?	—	—	—	—	*	—	— / —
21. Hierofalco (=Falco) candicans (Linné)	—	—	—	—	—	—	—	? / —
22. Anser albifrons (Scopoli) [1]	—	—	trsv.	+	*	—	—	* / *
23. Harelda (=Clangula) glacialis (Linné)	*	*	*	*	*	*	*	* / *
24. Erionetta (=Somateria) spectabilis (Pallas)	*	+	hib.	+	*	+	*	* / *
25. Urinator (=Gavia) stellatus (Pontoppidan)	*	*	*	*	*	*	*	* / *
26. Urinator (=Gavia) adamsi Gray	err.	—	hib.	*	*	—	*	* / *
*=Species that breed regularly	10	6	11	8	11	12	12	16 / 14
+=Species breeding in limited numbers	7–6	5	2	7	6	3	6	2–3? / 2
hib.=Species wintering	—	—	6	2	2	2	1	— / —
trsv.=Species occurring on migration	—	1	2	—	1	1	1	— / —
err.=Species of accidental occurrence	3	1	2	—	1	—	—	5 / —
Total number	20	13	23	17	21	18	20	23—24 / 16

[1] Regarding *Anser albifrons albifrons* (Scopoli) and *Anser albifrons gambeli* Hartlaub as a single species.

polar Species in the Eurasian Tundra.

Franz Josef Archipelago	Kara Sea, Yamal and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North coast of Chukchi Peninsula
IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
—	+	+	—	—	+	+	—	—	?+	+	—	+
*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	—	*	*	*	*
*	M. K.	*	hib.	*	—	—	*	*	—	—	*	+
err.	+	*	*	*	+	*	*	—	*	*	*	*
*	+	+	+	+	+	+	+	—	+	+	—	+
err.	+	*	*	*	*	*	*	—	*	*	err.	*
*	*	*	*	*	*	*	*	?*	*	*	*	*
*	M. K.	trsv.	hib.	*	—	—	*	*	—	+	*	*
—	—	—	—	+	+	—	err.	—	—	trsv.	—	err.
*	M. K.	*	rr. hib	hib	hib.	—	err.	*?	—	—	err.	rr. hib.
+	*	*	—	*	*	*	*	—	—	*	—	*
err.	*	*	*	*	*	*	*	—	—	err.	—	*
—	*	*	*	—	*	*	*	—	*	*	—	—
err. or +?	trsv. or *?	*	*	*	*	—	*	—	—	—	—	—
—	—	—	*	—	—	—	*	—	—	—	—	—
—	*	*	+	+	+	+	+	—	+	*	+ or *?	err.
*	*	*	*	*	*	*	*	*	err. or trsv?	*	*	*
—	*	*	*	*	?*	?*	err. or +?	—	—	?*	—	—
—	—	—	—	—	+?	—	—	—	—	—	—	—
? err.	+	—	—	—	+?	—	—	—	—	?+	—	?+
—	*	*	*	—	*	*	—	—	*	*	—	err.
—	*	*	*	*	*	*	*	Oc. Gl.	*	*	Oc. Gl.	*
*	+	*	*	*	*	*	*	Oc. Gl.	*	*	*	*
+	*	*	*	*	*	*	*	—	*	*	—	*
—	*	*	*	—	—	*	—	—	*	*	—	*
9	13–14	19	16	15	14	16	16	5–6?	11	14–15	?8–9	?13
2	6	2	3	3	7	2	2–3?	—	2–3?	3–4?	0–1?	3–4?
—	3	—	3	1	1	—	—	2	—	—	—	1
—	1?	1	—	—	—	—	—	—	1?	1	—	—
5	—	—	—	—	—	—	2–3?	—	1?	1	3	3
16	23	22	22	19	22	18	22	7–8	15	20	12	20–21

the Siberian Arctic Ocean and western North America as far as the Boothia peninsula but seems to be lacking in the eastern part of arctic America. Similarly, the continuity of the breeding grounds of the Knot, *Tringa canutus* Linné, has not been demonstrated; nevertheless I believe these three species of birds should be regarded as circumpolar since their breeding in these latitudes of both hemispheres is altogether regular and not accidental, and since the last-named of these species inhabits the little-developed portions of the tundra in the continental regions and must content itself with some of the arctic islands far separated one from another.

The distribution of the 26 arctic circumpolar species within the limits of the Eurasian tundra may be shown by the preceding table.

For the boreal circumpolar species, I am obliged to limit myself to a comparison of the lists of Professor Palmén (1887) with my own.

Boreal Circumpolar Species inhabiting the Eurasian Tundra.

Palmén, 1887	Pleske, 1928
1. Aegiothus linaria (Linné)	1. Aegiothus (=Acanthis) linaria linaria (Linné)
2. Aegiothus hornemanni exilipes (Coues)	
3. Hirundo riparia Linné	
4. Asio accipitrinus (Pallas)	2. Asio accipitrinus (Pallas) (=flammeus (Pontoppidan))
5. Sterna caspia Pallas	
6. Tringa alpina Linné (with the Amer. var.)	
7. Lagopus albus Gmelin	3. Lagopus lagopus lagopus (Linné)?
8. Anas boschas Linné	
9. Anas acuta Linné	4. Dafila (=Anas) acuta (Linné)
10. Anas clypeata Linné	
11. Fuligula marila Linné	
	5. Histrionicus histrionicus histrionicus (Linné)?
	6. Heniconetta (=Polysticta) stelleri (Pallas)?
12. Mergus serrator Linné	7. Merganser (=Mergus) serrator (Linné)
13. Podiceps griseigena Boddaert	
14. Podiceps auritus Linné	

As to Professor Palmén's list of boreal circumpolar birds that also inhabit the tundra zone to some extent, I believe that it should be reduced from 14 to 5, for in my opinion, *Hirundo riparia* Linné, *Sterna caspia* Pallas, *Anas boschas* Linné, *Anas clypeata* Linné, and *Podiceps auritus* Linné are not to be reckoned among those species found in part on the tundra itself, but have been recorded at the northern limit of the subalpine zone; while *Tringa alpina* Linné, *Fuligula marila* (Linné), and *Podiceps griseigena* Boddaert appear in different parts of the holarctic region as distinct subspecies so that they can no longer be regarded as circumpolar species. I have included *Lagopus lagopus lagopus* (Linné) with an interrogation mark, since I do not feel perfectly certain that the same

form inhabits the entire extent of the circumpolar tundra; also *Histrionicus histrionicus histrionicus* (Linné) and *Heniconetta* (=*Polysticta*) *stelleri* (Pallas)).

The distribution of the boreal circumpolar species within the limits of the Eurasian tundra may be shown by the following table. (See pages 446 and 447.)

B.—Species inhabiting the entire Eurasian Part of the Holarctic Region.

The table on pages 448 and 449 shows the distribution of the arctic and boreal species found in the tundra of the entire Eurasian part of the holarctic region. This table requires the following word of explanation. (1) We note first of all that the limits of distribution for these species at times extend beyond the Eurasian portion of the holarctic region and that a certain number of them occur as breeding species in Greenland while others have been found in Alaska. Neither the Atlantic Ocean, therefore, nor Bering Strait constitutes a zoögraphic boundary. (2) The boreal species of this category may be further subdivided into those that more or less regularly frequent the tundra zone, chiefly its southern border, and those whose occurrence in this zone is altogether accidental, the former constitute *subarctic* species while the latter represent the *boreal* species properly speaking.

C.—Species Characteristic of the Atlanto-European Province of the Holarctic Region.

The table on pages 450 and 451 shows us quite convincingly that a considerable list of species, arctic and boreal, inhabits only Greenland, Spitzbergen (including Bear Island) and the northern littoral of the Kola peninsula. These species avoid almost altogether the shores of the European mainland to the eastward of the mouth of the White Sea (1 species, 4.17 per cent, breeding; 2 species, 8.33 per cent, wintering; and 1 species, 4.17 per cent, accidental), Kolguev and Vaigach Islands (2 or 3 species, 8.33–12.5 per cent, breeding; 1 species, 4.17 per cent, wintering; and 3 species, 12.5 per cent, accidental). Some of these reappear in Nova Zembla and the Franz Josef archipelago, but do not extend their range farther eastward, and are not recorded, except as of accidental occurrence, from the neighboring parts of the Kara Sea.

Apparently, at an epoch when northern Europe was joined to Greenland by the now-submerged "Atlantis," the breeding species of these birds inhabited all the intermediate land area. With the disappearance of "Atlantis" beneath the waters of the Atlantic Ocean, there remained in Greenland a smaller (fifty per cent) colony of these species, while a much larger one has continued to exist in the eastern Atlantic and the latitudes of Barenz Sea. The limits of the Atlanto-European province of the Eurasian tundra might therefore be laid down as from eastern Greenland on the west, south along the Murman coast to a line crossing Barentz Sea north of Kolguev and Vaigach Islands; thence eastward to a line cutting the islands of Nova Zembla in a north-and-south direction (see map, p. 356).

Conditions of Occurrence of Boreal

	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolschesemelskaja tundra
Section	I	II	III	IV	V	VI
1. Aegiothus (=Acanthis) linaria linaria (Linné)	—	—	err. or +?	—	—	err. or +?
2. Asio accipitrinus (Pallas) (=flammeus (Pontoppidan))	—	—	+	—	—	—
3. Lagopus lagopus (Linné) subsp. div.	—	—	+[1]	+[2]	*[2]	*[2]
4. Dafila (=Anas) acuta (Linné)	err.	err.	+	+	—	+
5. Histrionicus histrionicus histrionicus (Linné)	err.	—	err.	—	—	—
6. Heniconetta (=Polysticta) stelleri (Pallas)	—	—	+	—	—	—
7. Merganser (=Mergus) serrator (Linné)	—	—	+	—	+	—
*=Species breeding regularly	—	—	—	—	1	1
+=Species breeding in limited numbers	—	—	5–6?	2	1	1–2?
trsv.=Species occurring on migration	—	—	—	—	—	—
err.=Species of accidental occurrence	2	1	1–2?	—	—	0–1?
Total number	2	1	5	2	2	3

[1] *Lagopus lagopus kapustini* Serebrowsky. [2] Subsp.? [3] *Lagopus lagopus koreni* Thayer and Bangs + *teste* Serebrowsky. [4] *Lagopus lagopus birulai* Serebrowsky.

I should mention once more that the form of the Mute Ptarmigan, *Lagopus mutus* Montin, inhabiting the alpine zone in Norway and the Kola peninsula, was forced out of these regions to the southward and westward during the climax of the glacial period and later regained its former habitat, leaving two distinct subspecies that have since maintained themselves in the Alps and in Scotland respectively. I may add to the list of boreal species characteristic of the continental portion of this province: *Merula torquata torquata* (Linné) and *Cinclus aquaticus melanogaster* Brehm, which have not been recorded hitherto from the tundra zone properly speaking. There are likewise several species of terrestrial mammals that are only found in the European portion of this province, notably *Lemmus lemmus* (Linné), *Myopus schisticolor* (Lilljeborg) and the two forms of wild reindeer, *Rangifer tarandus* (Linné), proper to Spitzbergen and Russian Lapland. The eastern part of the Arctic Ocean of this province is strongly influenced by the Gulf Stream, and is inhabited by a number of marine mammals that appear to avoid the colder waters of the Kara Sea and do not penetrate thither. Among these latter may be mentioned *Halichoerus grypus* Fabricius, *Phocaena* and probably several species of baleen whales (*Balaenoptera, Megaptera*). I should also mention the colony of Greenland Seals (*Phoca groenlandica* Müller), a species of higher latitudes, which on the other

Circumpolar Species in the Eurasian Tundra.

Vaigach Island	Nova Zembla	Franz Josef Archipelago	Karra Sea, Yamal Peninsula, Mouth of Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chukche Peninsula
VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
—	— / —	—	?+	?+	—	—	—	—	—	—	—	—	—	—
—	— / —	—	+	—	—	—	+	—	—	—	+	+	—	—
trsv.? or +?	? / ?	—	*2	*3	—	—	*3	*4	*4	*2	*4	*3	—	*2
+	— / —	—	+	+	err.	—	+	+	—	—	+	+	—	+
—	— / —	—	—	err.	—	—	—	—	—	—	—	—	—	—
—	err. / —	—	*	—	+	+	*	*	+	—	*	*	*	*
+	* / +	—	+	—	—	—	—	—	—	—	—	—	—	—
—	1 / —	—	2	1	—	—	2	2	1	1	2	2	1	2
2–3?	1? / 1–2?	—	4	2	1	1	2	1	1	—	2	2	—	1
1?	— / —	—	—	—	—	—	—	—	—	—	—	—	—	—
—	— / —	—	—	1	1	—	—	—	—	—	—	—	—	—
3	1–2? / 1–2?	0	6	4	2	1	4	3	2	1	4	4	1	3

hand, during its breeding period, avoids those regions influenced by the Gulf Stream, and resorts regularly to the mouth of the White Sea.

It is evident that the tundra zone, which at the present time only occupies on the mainland in this province a narrow strip along the Murman coast, extended much farther to the southward at the close of the glacial epoch, and has left behind a very striking colony of arctic species, breeding on the eastern shores of the Baltic Sea, not only along the Gulf of Bothnia but also at a certain distance to the south of the Gulf of Finland. I may mention the following species: *Cepphus grylle* (Linné), *Somateria mollissima mollissima* (Linné), *Sterna macrura* Naumann, *Arenaria interpres* (Linné) and *Phalaropus hyperboreus* (Linné) (=*lobatus* (Linné)).

I esteem it useful to mention at this place that I am quite convinced of the fact that under the influence of the Gulf Stream the northern slopes of the Kjölen range and its prolongation into the interior of Russian Lapland have lost their snow- and ice-fields after the climax of the Glacial Period considerably earlier than the southern slopes of the same ranges. If the plausibility of this opinion would be accepted the logical consequence of it is, that, whereas the large glaciers and snow-fields of the southern slopes melted and finally disappeared only very slowly, the northern slopes of the mountain range of Russian Lapland, especially the Murman coast, have lost their glacial cover

	Greenland	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolschesemelskaja tundra	Vaigach Island
		I	II	III	IV	V	VI	VII
1. Arctic Species								
1. Corvus corax corax Linné	—	err.	—	*	+	—	+	—
2. Otocorys (= Eremophila) alpestris flava (Gmelin)	—	—	—	*	*	*	*	*
3. Anthus cervinus (Pallas)	—	—	—	*	*	*	*	+
4. Saxicola (= Oenanthe) oenanthe oenanthe (Linné)	—	—	—	+	+	err.	+	+
5. Eudromias (= Charadrius) morinellus (Linné)	—	?err.	—	*	—	*	*	*
6. Aegialitis (= Charadrius) hiaticula (Linné)	X	*[1]	+[1]	*[2]	*[2]	*[2]	*[2]	*[2]
7. Limonites (= Calidris) minuta minuta (Leisler)	—	—	—	*	—	*	*	*
8. Ancylochilus subarquatus (Güldenstädt) (= Calidris ferruginea (Brünnich))	—	—	—	trsv.	—	trsv.	trsv.	—
9. Falco peregrinus griseiventris Brehm	—	—	—	*	—	*	*	*
10. Anser erythropus (Linné)	—	—	—	+	+	—	—	—
2. Boreal Species								
11. Loxia curvirostra curvirostra (Linné)	—	—	err.	—	—	—	—	—
12. Passer montanus montanus (Linné)	—	—	—	err.	err.	—	—	—
13. Pyrrhula pyrrhula pyrrhula (Linné)	—	—	—	err.	—	—	—	—
14. Alauda arvensis arvensis Linné	—	—	—	err.	—	—	—	—
15. Budytes flava borealis Sundevall	—	—	—	+	—	—	—	—
16. Periparus (= Parus) ater ater (Linné)	—	—	—	err.	—	—	—	—
17. Aegithalos caudatus caudatus (Linné)	—	—	—	err.	—	—	—	—
18. Acanthopneuste (= Phylloscopus) borealis borealis (Blasius)	—	—	—	+	—	—	—	—
19. Cypselus (= Apus) apus apus (Linné)	—	err.	—	err.	—	err.	—	—
20. Upupa epops epops Linné	—	err.	—	—	—	—	—	—
21. Larus canus canus Linné	—	—	—	+	+	—	—	—
22. Totanus fuscus (Linné) (= Tringa erythropus (Pallas))	—	—	—	+	—	?err.	—	—
23. Tringoides (= Tringa) hypoleueus (Linné)	—	—	—	err.	—	—	—	—
24. Glottis (= Tringa) nebularius (Gunnerus)	—	—	—	—	—	—	—	—
25. Pavoncella (= Philomachus) pugnax (Linné)	—	—	—	+	+	*	*	*
26. Limonites (= Calidris) temminckii (Leisler)	—	—	—	*	+	*	*	*
27. Scolopax rusticola rusticola (Linné)	—	err.	—	—	—	—	—	—
28. Falco peregrinus peregrinus Linné	—	—	—	—	—	—	—	—
29. Aesalon (= Falco) aesalon (Tunstall)	—	err.	—	+	—	+	+	+
30. Haliaëtus (= Haliaëtus) albicilla (Linné)	X	—	—	+	+	—	+	+
31. Astur palumbarius (= Accipiter gentilis) subsp. dub.? (Linné)	—	—	—	+[3]	—	—	—	—
32. Cygnus cygnus cygnus (Linné)	X	?err.	—	+	—	—	+	—
33. Mareca (= Anas) penelope (Linné)	—	err.	err.	+	+	+	+	+
34. Nettion (= Anas) crecca (Linné)	—	err.	err.	+	+	—	—	—
35. Fuligula (= Nyroca) marila marila (Linné)	?X	—	—	+	+	+	+	—
36. Fuligula (= Nyroca) fuligula (Linné)	—	—	—	—	—	err.	—	—
37. Merganser (= Mergus) merganser merganser (Linné)	—	—	—	+	—	+	—	+
38. Mergus albellus Linné	—	—	—	err.	—	—	—	—
39. Urinator (= Gavia) arcticus arcticus (Linné)	—	—	—	*	*	*	*	*
X = Species recorded as nesting in Greenland	4	—	—	—	—	—	—	—
* = Species regularly nesting	—	1	—	9	4	9	9	8
+ = Species nesting in limited numbers	—	—	1	15	10	4	7	6
trsv. = Species recorded on migration	—	—	—	1	—	1	1	—
err. = Species of accidental occurrence	—	9	3	8	1	4	—	—
‡ = Species found in Alaska	—	—	—	—	—	—	—	—
Total number	4	10	4	33	15	18	17	14

Nova Zembla		Franz Josef Archipelago	Kara Sea, Yamal Pen., Mouth of Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chukchi Peninsula	Alaska
VIII a	VIII b	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	
err.	—	—	err.	err.	—	—	+	+	err.	—	+	+	err.	*	?‡
*	*	err.	*	*	—	—	*	—	—	—	—	—	—	—	—
—	—	—	*	*	+	—	*	—	—	—	—	+	—	err.	?‡
+	—	—	+	+	+	+	+	+	+	—	—	+	—	+	‡
*	*	—	*	*	*	*	*	—	+	—	—	+	—	*	—
*2	+2	—	*2	*2	+2	+2	+2	—	+? or err?2	—	—	*2	—	*2	—
*	—	—	*	*	*	*	*	—	*	—	*	—	—	—	—
—	—	—	trsv? or *?	*	*	—	trsv.	—	+	—	—	trsv.	—	trsv.	‡
*	*	—	*	*	—	—	*	—	+	trsv.	—	—	—	—	—
err.	—	—	+	+	+	—	+	+	+	—	+	err.	—	err.	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	+	—	—	+	—	err.	—	—	—	—	err.	‡
—	—	—	—	—	err.	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	+	—	—	—	—	—	—	—	—	?err.	trsv	‡
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	err.	—	—	—	—	—	—	—	—	—	—	—
err.	—	—	—	err.?	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	err.	—	—	—	—	—	—	—	—	—	—	—
—	—	—	?err.	—	?err.	—	?err.	—	—	—	—	—	—	—	—
—	—	—	+	+	+	—	+	+	err.	—	+	*	—	—	—
—	—	—	*	*	*	—	+	—	—	—	—	*	—	err.	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	*	—	—	*	*	—	*2	—
+	—	—	+	+	+	—	—	+	—	—	—	—	—	?+	—
+	—	—	+	—	+	—	—	—	—	err.	?+	+	—	—	—
—	—	—	—	—	—	—	—	?err.	—	—	—	?err.	—	—	—
?err.	—	—	—	—	—	—	+	+	—	—	—	—	—	—	—
err.	—	—	+	+	—	—	+	—	—	—	—	—	—	—	—
err.	—	—	+	+	—	—	+	—	—	—	—	—	—	—	—
—	—	—	+	+	—	—	—	—	—	—	—	—	—	—	?‡
—	—	—	—	—	—	—	—	?+	—	—	—	—	—	—	—
+	—	—	—	+	—	—	—	—	—	—	+	—	—	—	—
err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
*	*	—	*	*	*	—	*	*	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	4	—	8–9?	9	5	2	6	2	1	—	2	4	—	4	—
4	1	—	8	9	7	2	10	7	5–6?	—	5	5	—	2	—
—	—	—	1?	—	—	—	1	—	—	1	—	1	—	2	—
6	—	1	2	4	2	—	1	1	3–4?	1	—	3	2	4	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?
16	5	1	19	22	14	4	18	10	10	2	7	13	2	12	?

[1]*Aegialitis hiaticula hiaticula* (Linné). [2]*Aegialitis hiaticula tundrae* Lowe. [3]*Astur palumbarius moscoviae* Sushkin or *buteoides* Menzbier ♂*moscoviae* Sushkin.

Species Characteristic of the Atlanto-

	Greenland	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolschesemelskaja tundra
		I	II	III	IV	V	VI
1. Arctic Species							
1. Fraterecula arctica (Linné)	X	*	*	*	—	—	—
2. Uria lomvia lomvia (Linné)	X	*	*	*	hib.	hib. Oc. Gl.	—
3. Mergulus (=Alle) alle (Linné)	X	*	*	hib.	—	—	—
4. Lagopus hyperboreus Sundevall	—	*	+	—	—	err?	—
5. Lagopus mutus Montin	—	—	—	*	?*	err.[1]	?err.[2]
6. Melanonyx (=Anser) brachyrhynchus (Baillon)	X	*	trsv.	?+	—	—	—
7. Melanonyx (=Anser) neglectus (Sushkin)	—	—	—	—	—	+	—
8. Branta leucopsis (Bechstein)	X	*	—	trsv.	—	+	—
9. Somateria mollissima borealis (Brehm)	X	*	*	—	—	—	—
10. Phalacrocorax carbo (Linné)	X	—	—	*	—	—	—
2. Boreal Species							
11. Sturnus vulgaris Linné	—	—	err.[3]	err.[4]	—	—	—
12. Anthus spinoletta littoralis (Brehm)	—	—	err.	*	—	—	—
13. Merula merula merula (Linné)	—	—	err.	—	—	—	—
14. Chelidon (=Delichon) urbica urbica (Linné)	—	—	—	—	—	err.	—
15. Coracias garrulus garrulus (Linné)	—	—	—	—	—	—	—
16. Dryobates leuconotus leuconotus (Bechstein)	—	—	—	?err.	—	—	—
17. Uria troille (Linné)	X	err.	*	*	—	—	—
18. Cepphus grylle (Linné)	X	—	—	*	hib. or +?	—	—
19. Alca torda (Linné)	X	err.	err.	*	—	—	—
20. Megalestris catarrhactes (Linné) (=Stercorarius skua (Brünnich))	X	err.	err.	err.	—	err.	—
21. Larus fuscus fuscus Linné	—	—	—	+	—	—	—
22. Larus argentatus omissus Sushkin	—	—	—	*	—	—	—
23. Grus (=Megalornis) cinerea subsp.?	—	—	—	—	—	—	—
24. Turtur (=Streptopelia) turtur turtur (Linné)	—	—	—	err.	—	—	—
25. Phalacrocorax graculus graculus (Linné)	—	—	—	+	—	—	—
26. Sula (=Moris) bassana (Linné)	X	—	—	err.	—	—	—
X=Species recorded as breeding in Greenland	12						
*=Species that breed regularly	—	7	5	9	1	—	—
+=Species that breed in limited numbers	—	—	1	3	1?	2	—
trsv.=Species recorded on migration	—	—	1	1	—	—	—
hib.=Species that winter in the adjacent parts of the Arctic Ocean	—	—	—	1	1–2?	1	—
err.=Species of accidental occurrence	—	3	5	5	—	3	1
Total number	12	10	12	19	3	6	1

[1] Or *Lagopus hyperboreus* Sundevall. [2] Subsp.? or *Lagopus rupestris* (Gmelin)? [3] Subsp.? [4] *intermedius* Prazak.

much earlier and have also earlier undergone the processes in the soil necessary for reception at first of an alpine and afterwards of a subalpine or shrub vegetation. This subalpine zone could be peopled also much earlier by animals and evidently not from Europe,

European Province of the Holarctic Region.

Vaigach Island	Nova Zembla		Franz Josef Archipelago	Kara Sea, Yamal and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chukch Peninsula
VII	VIII a	VIII b	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
—	*	*	*	—	—	—	—	—	—	—	—	—	—	—	—
—	*	*	*	hib. M. K.	—	—	—	—	—	—	—	—	—	—	—
—	hib.	*	*	—	—	—	—	—	—	—	—	—	—	—	—
—	—	?	+	—	—	—	—	—	—	—	—	—	—	—	—
?+?	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	*	?*	—	—	—	—	—	—	—	—	—	—	—	—	—
—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	err.	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	*	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	err.	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	4	4	3	—	—	—	—	—	—	—	—	—	—	—	—
1?	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—
—	4	—	—	1	1	—	—	—	—	—	—	—	—	—	—
1?	10	4	4	2	1	0	0	0	0	0	0	0	0	0	0

separated from the Murman coast by immense glaciers and snow-fields, but from Siberia. The very narrow strip of the subalpine region along the Murman coast and especially its western parts now supports a series of animal species undoubtedly of Siberian origin, not only of birds, but also of mammals and flies. Of such birds I can enumerate: 1)

Species Characteristic of the Tundra of the

	Greenland	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolsheseme-lskaja tundra
		I	II	III	IV	V	VI
1. *Arctic Species*							
1. Rufibrenta (=Branta) ruficollis (Pallas)	—	—	—	—	—	—	—
2. *Boreal Species*							
2. Budytes citreola citreola (Pallas)	—	—	—	—	—	—	+
3. Phylloscopus tristis Blyth	—	—	—	—	—	—	+
4. Larus argentatus antelius Iredale	—	—	—	hib.	*	*	*
5. Larus argentatus taimyrensis Buturlin	—	—	—	—	—	—	—
*=Species that breed regularly	—	—	—	—	1	1	1
+=Species that breed in limited numbers	—	—	—	—	—	—	2
hib.=Species that winter in these latitudes	—	—	—	1	—	—	—
err.=Species of accidental occurrence	—	—	—	—	—	—	—
Total number	—	—	—	1	1	1	3

Acanthopneuste (=*Phylloscopus*) *borealis borealis* (Blasius) nesting regularly in the western, subalpine parts of the Murman coast; 2) *Cuculus optatus* Gould found by Rae in the subalpine region near the watershed between the Arctic Ocean and the White Sea in the neighborhood of Masselga Station, named by Rae *Cuculus doctor* and distinguished by its call note: *hup, hup, hup;* 3) the shrike form designated by Bogdanow as *Lanius borealis europaeus,* representing a product of hybridization of the Siberian *Lanius borealis sibiricus* Bogdanow and the European *Lanius excubitor* Linné. I have had occasion during my trip to Lapland to persuade myself of the hybrid origin of this bird, by finding in the same brood young birds with two white speculums on the wings (the true *Lanius excubitor* Linné) and others with a single speculum (*Lanius borealis europaeus* Bogdanow = *Lanius major* Pallas). 4) *Heniconetta* (=*Polysticta*) *stelleri* (Pallas) nesting regularly in the subalpine region in the vicinity of the Varanger Fjord and in the western parts of the Murman coast. Of mammals I will enumerate only two species of *Evotomys, Evotomys rufocanus* (Sundevall) and *Evotomys rutilus* (Pallas) largely distributed throughout Siberia and abundant also in Lapland. Finally I must recall a representative of the flies, the *Stratiomyia validicornis validicornis* Loew. This fly was described by Loew from the Transbaikalian province of East Siberia and redescribed in 1864 as *Stratiomyia paludosa* by Siebke from northern Norway. In 1899 I expressed the supposition of the identity of these two species but was naturally very astonished that they were found at a distance of

Europeo-Siberian Province of the Holarctic Region.

Vaigach Island	Nova Zembla		Franz Josef Archipelago	Kara Sea, Yamal and Mouth of Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chukche Peninsula
VII	VIII a	VIII b	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
—	err.	—	—	+	*	*	+	—	—	—	—	—	—	—	—
—	—	—	—	+	+	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
*	+	—	—	*	—	err.	—	—	—	—	—	—	—	—	—
—	—	—	—	+	*	*	+	—	?	—	—	—	—	—	—
1	—	—	—	1	2	2	—	—	—	—	—	—	—	—	—
—	1	—	—	3	2	—	2	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—
1	2	—	—	4	4	3	2	—	?1	—	—	—	—	—	—

6000 kilometers from one another. But afterwards I have had the possibility to convince myself of the correctness of my view having received further materials from countries intermediate between the two almost extreme points, namely from the course of the Pechora River (some specimens) and from different localities of western Siberia (27 specimens).

D.—Species Characteristic of the Europeo-Siberian Province of the Eurasian Tundra.

Although my list of birds characteristic of this province contains but five species, of which one is arctic and four are boreal, I do not for a moment hesitate to establish it, in view of the fact that on the one hand I am able to complete it by several boreal species of mammals and birds that have not been previously recorded from the tundra region proper, and on the other hand by the fact that a considerable list of species, enumerated farther on and inhabiting the entire extent of the two neighboring provinces—Atlanto-European and Europeo-Siberian—do not range beyond the eastern limit of the latter province.

Among mammals I may cite *Lemmus obensis* Brants, which is found only to the eastward of the White Sea; *Eutamias asiaticus* (Gmelin) which does not normally pass the Dwina; and the marten (*Martes zibellina* (Gmelin)) which reaches the westward limit of its distribution in the northern Ural. Among birds I may enumerate: *Locustella lanceolata* (Pallas), *Loxia bifasciata* Gmelin; *Terekia cinerea* (Güldenstädt); the first of these

	Greenland	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolshesemelskaja tundra	Vaigach Island
1. *Arctic Species*		I	II	III	IV	V	VI	VII
1. Arquatella (=Calidris) maritima maritima (Gmelin)	X	*	*	*	—	+	—	*
2. Pelidna (=Calidris) alpina alpina (Linné)	—	+	—	+	+	*	*	*
3. Hierofalco gyrfalco (Linné) (=Falco rusticolus Linné)	—	—	—	*	*	—	*	?+
4. Cygnus bewickii bewickii Yarrell	—	?err.	—	trsv.	—	*	*	*
5. Melanonyx segetum segetum (Gmelin) (=Anser fabalis (Latham))	—	—	—	—	+	*	—	+
6. Melanonyx arvensis arvensis (Naumann) (=Anser fabalis (Latham))	—	—	—	+	—	*	—	—
7. Branta bernicla bernicla (Linné)	X	*	trsv.	trsv.	—	*	—	*
8. Somateria mollissima mollissima (Linné)	—	—	—	*	+	+	—	*
9. Fulmarus glacialis glacialis (Linné)	X	*	*	Oc. Gl.	Oc. Gl.	Oc. Gl.	—	—
2. *Boreal Species*								
10. Corone (=Corvus) cornix cornix (Linné)	—	err.	err.	+	—	—	—	—
11. Trypanocorax (=Corvus) frugilegus frugilegus (Linné)	—	err.	—	err.	—	—	—	—
12. Passer domesticus domesticus (Linné)	—	—	—	err.	—	—	—	—
13. Motacilla alba alba Linné	X	—	—	+	+	+	+	—
14. Anthus pratensis (Linné)	X	—	—	+	—	+	+	—
15. Hedimela atricapilla atricapilla (Linné) (=Muscicapa hypoleuca (Pallas))	—	—	—	err.	—	—	—	—
16. Phylloscopus trochilus (Linné)	—	—	—	+	+	—	+	—
17. Turdus pilaris Linné	—	err.	—	+	+	—	+	—
18. Turdus iliacus Linné (=musicus Linné)	—	err.	err.	+	+	—	+	—
19. Cyanecula (=Luscinia) svecica svecica (Linné)	—	—	—	+	+	+	—	—
20. Phoenicurus phoenicurus phoenicurus (Linné)	—	—	—	err.	—	—	—	—
21. Hirundo rustica rustica Linné	—	?err.	—	+	—	—	—	—
22. Larus marinus Linné	X	—	err.	+	*	?+	*	*
23. Sterna hirundo hirundo Linné	X	—	—	err.	—	—	—	—
24. Haematopus ostralegus Linné	X	err.	err.	*	*	—	—	—
25. Charadrius pluvialis Linné (=apricarius Linné)	X	—	—	+	+	+	*	*
26. Numenius phaeopus (Linné)	X	+	err.	+	?+	—	—	—
27. Limosa lapponica lapponica (Linné)	—	—	—	+	+	err.?	err.	—
28. Gallinago (=Capella) gallinago gallinago (Linné)	—	—	—	+	+	—	+	—
29. Archibuteo (=Buteo) lagopus lagopus (Brünnich)	—	—	—	+	+	—	—	*
30. Oidemia fusca fusca (Linné)	—	+	—	+	+	+	+	+
31. Oidemia nigra nigra (Linné)	—	+	+	—	+?	+	+	*
32. Pedetaithya (=Podiceps) griseigena griseigena (Boddaert)	—	err.	—	—	—	—	—	—
X = Species recorded breeding in Greenland	10							
* = Species that breed regularly	—	3	2	4	3	5	6	9
+ = Species that breed in limited numbers	—	4	1	17	15	9	8	3
trsv. = Species recorded as migrants	—	—	1	2	—	—	—	—
hib. = Species that winter in the adjacent parts of the Arctic Ocean	—	—	—	1	1	1	—	—
err. = Species of accidental occurrence	—	8	5	5	—	1	1	—
Total number	10	15	9	29	19	16	15	12

Nova Zembla		Franz Josef Archipelago	Kara Sea, Yamal and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chukchi Peninsula
VIII a	VIII b	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
*	*	*	*	*	*	*	?+	—	?err.	—	—	—	—	—
+	—	—	*	*	+	—	+	—	—	—	—	—	—	—
?+	—	—	—	—	?+	—	—	—	—	—	—	—	—	—
*	—	—	*	*	*	—	*	—	—	—	—	—	—	—
+	?	—	*	+	—	—	—	—	—	—	—	—	—	—
*	*	—	*	+	—	—	—	—	—	—	—	—	—	—
trsv.	*	*	*	*	*	*	—	—	—	—	—	—	—	—
*	*	*	*	*	—	—	—	—	—	—	—	—	—	—
*	*	*	Oc. Gl	*1	—	err. Oc. Gl.	—	—	—	—	—	—	—	—
err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	+	+	—	—	—	—	—	—	—	—	—	—
—	—	—	?+	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	+	+	—	—	—	—	—	—	—	—	—	—
—	—	—	+	+	—	—	—	—	—	—	—	—	—	—
—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
—	—	—	+	+	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
err.	—	err.	—	—	—	—	—	—	—	—	—	—	—	—
—	—	?err.	?+	?err.	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
err.	—	—	+	*	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	+	+	—	+	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
+	—	—	+	+	—	—	—	—	—	—	—	—	—	—
+	—	—	+	+	+	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	5	4	7	7	3	2	1	—	—	—	—	—	—	—
5	1?	—	9	10	4	—	3	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
5	—	2	—	1	—	1	—	—	1	—	—	—	—	—
16	5–6	6	17	18	7	3	4	—	1	—	—	—	—	—

[1] Probably a breeding colony on Lonely Island.

Species Characteristic of the Tundra of the

	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolschesemelskaja tundra
1. *Arctic Species*	I	II	III	IV	V	VI
1. Rhodostethia rosea (Macgillivray) [1]	?err.	—	—	—	—	—
2. Larus argentatus birulai Sushkin	—	—	—	—	—	—
3. Cygnus bewickii jankowskii Alphéraki	—	—	—	—	—	—
4. Melanonyx arvensis (= Anser fabalis) sibiricus Alphéraki	—	—	—	—	—	—
2. *Boreal Species*						
5. Corone (= Corvus) corone levaillanti (Lesson)	—	—	—	—	—	—
6. Cynchramus (= Emberiza) schoeniclus polaris (Middendorff)	—	—	—	—	—	—
7. Motacilla alba ocularis Swinhoe	—	—	—	—	—	—
8. Anthus trivialis hodgsoni Richmond	—	—	—	—	—	—
9. Anthus spinoletta japonicus Temminck and Schlegel	—	—	—	—	—	—
10. Otomela cristata cristata (Linné)	—	—	—	—	—	—
11. Reguloides superciliosus superciliosus (Gmelin) (= Phylloscopus humei praemium Mathews & Iredale)	—	—	—	—	—	—
12. Charadrius dominicus fulvus Gmelin	—	—	—	—	—	—
13. Limonites (= Calidris) minuta ruficollis (Pallas)	—	—	—	—	—	—
14. Gallinago (= Capella) gallinago raddei Buturlin	—	—	—	—	—	—
15. Sarcogeranus leucogeranus (Pallas)	—	—	—	—	—	—
16. Archibuteo (= Buteo) lagopus pallidus Menzbier	—	—	—	—	—	—
17. Melanonyx segetum (= Anser fabalis) serrirostris (Swinhoe)	—	—	—	—	—	—
* = Species that breed regularly	—	—	—	—	—	—
+ = Species that breed in limited numbers	—	—	—	—	—	—
hib. = Species that winter in the adjacent parts of the Arctic Ocean	—	—	—	—	—	—
err. = Species of accidental occurrence	1	—	—	—	—	—
Total number	1	—	—	—	—	—

[1] The Rosy Gull, from its nesting places in the thickets of the subalpine zone, should be placed among the boreal species, but since it is a bird of high arctic latitudes at the non-breeding times of year, I have placed it among the arctic species.

extends slightly beyond the Dwina while the two others regularly breed only in the latitudes of this river and to the eastward of it. In the lower course of the Pechora, not far from the tundra, we meet with a species widespread in Siberia, namely *Anthus gustavi* Swinhoe, while in the northern Ural *Calliope camtschatkensis* (Pallas) and *Nemura cyanura* (Pallas) reach the western limit of their range. All these species lend a Siberian tinge to the fauna of this province, quite justifying the appelation given it by Seebohm of "Siberia in Europe," and have decided me to call it "Europeo-Siberian." This province embraces therefore in its arctic portions: the Kanin peninsula, Kolguev and Vaigach Islands, the Bolschesemelskaja tundra, the tundra of the Ob region, the left bank of

Sibero-American Province of the Holarctic Region.

Vaigach Island	Nova Zembla		Franz Josef Archipelago	Kara Sea, Yamal Peninsula, and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chukchie Peninsula
VII	VIII a	VIII b	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
—	—	—	hib.	—	—	—	—	—	—	hib.	hib.	*	*	hib.	?hib.
—	—	—	—	—	—	*	*	*	*	*	?*	?+	+	—	+
—	—	—	—	—	—	—	—	*	*	—	—	?+	*	—	?+
—	—	—	—	—	—	+	—	*	*	err.	—	?+	+	—	*
—	—	—	—	—	—	—	—	—	—	err.	—	—	err.	—	?+
—	—	—	—	—	—	—	err.	—	—	—	—	—	—	—	—
—	—	—	—	—	+	+	—	+	+	err.	—	?+	+	—	err.
—	—	—	—	—	—	—	err.	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.	—
—	—	—	—	—	+	?err.	err.	—	—	—	—	—	—	—	—
—	—	—	—	+	*	+	—	*	—	*	—	—	*	?err.	—
—	—	—	—	—	—	—	err.	err.	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	+	—	—	—	+	+	—	—
—	—	—	—	—	—	—	—	—	+	—	—	err.	err.	—	—
—	—	—	—	+	+	—	—	—	*	?+	—	+	+	—	—
—	—	—	—	—	+	—	—	+	*	—	—	—	+	—	*
—	—	—	—	1	1	1	1	4	5	2	?1	1	3	—	2
—	—	—	—	2	4	3	—	4	2	1	—	6	6	—	3
—	—	—	1	—	—	—	—	—	—	1	1	—	—	1	1
—	—	—	—	—	—	?1	4	1	—	3	—	1	2	2	3
—	—	—	1	2	5	5	5	9	7	7	1–2	8	11	3	9

the Yenisei in the forest and the subalpine regions, and the entire Taimyr peninsula in the alpine region (the tundra). To the eastward of the Dwina its boreal portions extend to the Yenisei region, which, as far as the latitude of Dudinka, represents a very distinct boundary that the Asiatic species do not pass except casually. From Dudinka the line passes northeastward and, following the course of the Chatanga, reaches the shores of the Arctic Ocean at Chatanga Bay. This frontier therefore coincides completely with that traced by Professor Suess for his continent Angar. In the boreal portions of the Yenisei valley are found on the one hand a series of forms of European affinity and on the other, many species characteristic of eastern Siberia. As a result of this intermingling of species that leave their common breeding grounds in autumn, the young individuals (chiefly) of Siberian species at times by mistake accompany,

Species Characteristic of the Sibero-American and

	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolshezemelskaja tundra	Vaigach Island
1. *Arctic Species*	I	II	III	IV	V	VI	VII
1. Uria lomvia arra (Pallas)	—	—	—	—	—	—	—
2. Larus argentatus birulai Sushkin	—	—	—	—	—	—	—
3. Heteropygia (=Calidris) maculata (Vieillot) [1]	—	—	—	—	—	—	—
4. Heteropygia (=Calidris) acuminata (Horsfield)	—	—	—	—	—	—	—
5. Branta bernicla nigricans (Lawrence)	—	—	—	—	—	—	—
6. Arctonetta fischeri (Brandt)	—	—	—	—	—	—	—
2. *Boreal Species*							
7. Cyanecula (=Luscinia) svecica robusta Buturlin	—	—	—	—	—	—	—
8. Limosa lapponica novae-zealandiae Gray	—	—	—	—	—	—	—
9. Oidemia fusca stejnegeri (Ridgway)	—	—	—	—	—	—	—
10. Oidemia nigra americana (Swainson and Richardson)	—	—	—	—	—	—	—
*=Species that breed regularly	—	—	—	—	—	—	—
+=Species that breed in limited numbers	—	—	—	—	—	—	—
‡=Species found in Alaska	—	—	—	—	—	—	—
trsv.=Species recorded as migrants	—	—	—	—	—	—	—
hib.=Species that winter in the adjacent parts of the Arctic Ocean	—	—	—	—	—	—	—
err.=Species of accidental occurrence	—	—	—	—	—	—	—
m.=Moulting	—	—	—	—	—	—	—
Total number	—	—	—	—	—	—	—

[1] *Heteropygia* (=*Calidris*) *maculata* (Vieillot) also inhabits the nearctic subregion of the holarctic region.

not the flocks of their own species passing eastward from the Yenisei to their winter-quarters in southeastern China or South Asia and their islands, but instead join with flocks of neighboring European species, and passing westward, reach even western Europe in company with these European species (for example, several species of Thrushes, *Turdus ruficollis* Pallas, *Turdus fuscatus* Pallas, *Turdus naumanni* Temminck, *Turdus atrigularis* Temminck, and *Turdus sibiricus* Pallas; *Agrodroma richardii* Vieillot; *Reguloides superciliosus* (Gmelin)). On the other hand, European species occasionally join with Siberian species, and accompany them to the eastward instead of following their normal route leading to Europe.

As to the Taimyr peninsula, it has been the longest buried under blankets of permanent snow and ice, and has received its bird population last of all and entirely from the European side instead of from eastern Siberia. This fact explains perfectly the necessity for drawing the boundary line for the arctic areas, not along the course of the Yenisei but along a line that unites Dudinka on the Yenisei with Chatanga Bay.

North Pacific Provinces of the Holarctic Region.

Nova Zembla		Franz Josef Archipelago	Kara Sea, Yamal, and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast Chukchi Peninsula	Alaska
VIII a	VIII b	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	
—	—	—	—	—	—	*	hib.	—	*	*	—	hib.	*	*	‡
—	—	—	—	—	*	*	*	*	*	?*	?+	+	—	+	—
—	—	—	—	—	err.	err.	+	—	err.	—	—	*	err.	*	‡
—	—	—	—	—	—	—	trsv.	—	—	—	+	+?	—	?*	‡
—	—	—	—	—	—	—	*	*	+	err. or +?	*	err.	m.	*	‡
—	—	—	—	—	—	—	+	+	err.	—	*	*	—	*	‡
—	—	—	—	—	—	+	+	—	—	—	—	—	—	+	‡
—	—	—	—	—	—	—	—	+	err. or +?	—	+	+	—	err.	‡
—	—	—	—	—	—	+	—	—	—	—	—	+	—	*	‡
—	—	—	—	—	—	—	+	+	—	—	+	+	—	—	‡
—	—	—	—	—	1	2	2	2	2	2	2	2	1	6	—
—	—	—	—	—	—	2	4	3	1–2?	1?	4	5	—	2	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—
—	—	—	—	—	1	1	—	—	2–3?	1?	—	1	1	1	—
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	—	—	—	2	5	8	5	6	3	6	9	3	9	9

E.—Species inhabiting the Atlanto-European and Europeo-Siberian Provinces of the Holarctic Region.

The arctic and boreal species enumerated in the table (p. 454–455) inhabit both of the adjoining provinces mentioned. The arctic species extend farther to the eastward and occupy not only the whole of Taimyr but in some cases have been recorded even from the region of the mouth of the Lena. The boreal species, on the contrary, with two exceptions, do not go beyond the Yenisei River.

F.—Species Characteristic of the Sibero-American Province of the Holarctic Region and Species Characteristic of the Sibero-American and North Pacific Provinces of the Holarctic Region.

From a comparative study of the two lists subjoined we may see at once that the avifauna of the tundra of the province which I have designated as Sibero-American, in its composition, apart from those species that are circumpolar and characteristic of the entire Eurasian portion of the tundra of the Holarctic region, is made up of a number of species that are particularly Siberian as well as a certain number that are equally characteristic of the lands bordering the North Pacific. These latter species lend to the

Species Characteristic of the North Pacific

	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolschesemelskaja tundra	Vaigach Island	Nova Zembla	
1. *Arctic Species*	I	II	III	IV	V	VI	VII	VIII a	VIII b
1. Fratercula corniculata (Naumann)	—	—	—	—	—	—	—	—	—
2. Lunda cirrhata Pallas	—	—	—	—	—	—	—	—	—
3. Pseuduria (=Cepphus) columba (Pallas)	—	—	—	—	—	—	—	—	—
4. Simorhynchus (=Aëthia) cristatellus (Pallas)	—	—	—	—	—	—	—	—	—
5. Ciceronia (=Aëthia) pusilla (Pallas)	—	—	—	—	—	—	—	—	—
6. Brachyrhamphus brevirostris (Vigors)	—	—	—	—	—	—	—	—	—
7. Ombria (=Phalcris) psittacula (Pallas)	—	—	—	—	—	—	—	—	—
8. Arenaria melanocephala (Vigors)	—	—	—	—	—	—	—	—	—
9. Eurynorhynchus pygmaeus (Linné)	—	—	—	—	—	—	—	—	—
10. Arquatella (=Calidris) maritima couesi (Ridgway)	—	—	—	—	—	—	—	—	—
11. Philacte canagica (Sevastianow)	—	—	—	—	—	—	—	—	—
12. Somateria mollissima v-nigrum Gray	—	—	—	—	—	—	—	—	—
13. Phalacrocorax pelagicus (Pallas)	—	—	—	—	—	—	—	—	—
14. Fulmarus glacialis rodgersi (Cassin)	—	—	—	—	—	—	—	—	—
2. *Boreal Species*								—	—
15. Larus schistisagus Stejneger	—	—	—	—	—	—	—	—	—
16. Larus glaucescens Naumann	—	—	—	—	—	—	—	—	—
17. Heteractitis (=Tringa) incanus (Gmelin)	—	—	—	—	—	—	—	—	—
18. Haliaëtus (=Haliacëtus) leucocephalus alascanus Townsend	—	—	—	—	—	—	—	—	—
*=Species that breed regularly	—	—	—	—	—	—	—	—	—
+=Species that breed in limited numbers	—	—	—	—	—	—	—	—	—
trsv.=Species found on migration	—	—	—	—	—	—	—	—	—
err.=Species of accidental occurrence	—	—	—	—	—	—	—	—	—
Oc. Gl.=Species inhabiting the Arctic Ocean the whole year round and perhaps breeding in suitable places	—	—	—	—	—	—	—	—	—
Total number	—	—	—	—	—	—	—	—	—

avifauna of this province a somewhat American aspect that has constrained me to designate it as Sibero-American by analogy with the Europeo-Siberian province. The western limit of the first province, at least for the boreal (or rather subarctic) species, is found in the region of the lower Yenisei (forest and subalpine region) and from a line uniting Dudinka with the mouth of the Chatanga (alpine region). Some of these arctic species, notably the Siberian, appear only after passing the region of the Lena delta, while some species characteristic also of the North Pacific province and which do not become more common until after passing the mouth of the Lena, have been found breeding also in the Taimyr peninsula. I trace the eastern boundary of

Province of the Holarctic Region.

Franz Josef Archipelago	Kara Sea, Yamal, and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chuckchi Peninsula	Alaska
IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	
—	—	—	—	—	—	—	—	—	—	—	err.	err.	‡
—	—	—	—	—	—	—	—	—	—	—	—	err.	‡
—	—	—	—	—	—	—	—	—	—	—	*	*	‡
—	—	—	—	—	—	—	—	—	—	err.	+	—	‡[1]
—	—	—	—	—	—	—	—	—	—	—	—	err.	‡
—	—	—	—	—	—	—	—	—	—	—	—	err.	‡[1]
—	—	—	—	—	—	—	—	—	—	—	—	err.	‡[1]
—	—	—	—	—	—	—	—	—	—	err.	?err.	err.	‡
—	—	—	—	—	—	—	—	—	—	—	—	*	‡?[2]
—	—	—	—	—	—	—	—	—	—	—	—	*	‡
—	—	—	—	—	—	—	—	—	—	—	—	+	‡
—	—	—	—	—	+?	—	—	—	—	err.	—	*	‡
—	—	—	—	—	?err.	—	—	—	—	—	*	*	‡[1]
—	—	—	—	—	—	—	—	—	—	Oc. Gl.	Oc. Gl.	Oc. Gl.	‡
—	—	—	—	—	—	?	—	—	—	—	err.	—	?
—	—	—	—	—	—	—	—	—	—	trsv.	—	—	‡
—	—	—	—	—	—	—	—	—	—	—	—	err.	‡
—	—	—	—	—	—	—	—	—	—	?err.	—	err.	‡
—	—	—	—	—	—	—	—	—	—	—	2	5	—
—	—	—	—	—	1	—	—	—	—	—	1	1	—
—	—	—	—	—	—	—	—	—	—	1	—	—	—
—	—	—	—	—	1	?	—	—	—	4	3	8	—
—	—	—	—	—	—	—	—	—	—	1	1	1	—
—	—	—	—	—	2	1?	—	—	—	6	7	15	17

[1] These species have been found on the Aleutian Islands only.

[2] This species has not been recorded breeding on the east of Bering Strait, but it winters there, at times in considerable abundance.

this province in the region of Chaun Bay, on the north coast of the Chuckchi peninsula. This province obviously includes also the two archipelagoes of this part of the Arctic Ocean, namely, the New Siberian and the De Long archipelagoes. As boreal species that give an American aspect to this province, but do not appear in the tundra zone, I may mention only *Hylocichla minima aliciæ* Baird and *Pyrrhula cassini* Baird. The mammals inhabiting the forest zone of eastern Siberia offer much more convincing evidence in this regard: representatives of the genera *Alces, Cervus, Ovis, Citellus, Mar-*

mota, and *Vulpes* all offer connecting links between the European and Europeo-Siberian forms and the American forms. The Old World forms cannot in any case be regarded as completely identical with those of America, but although representing distinct subspecies or even distinct species, they clearly demonstrate their parental relationship to the American forms. I may further mention in this connection, the occurrence in certain rivers emptying into the Arctic Ocean, of fish of the genus *Catostomus*, a group even more widely spread in America.

G.—Species Characteristic of the North Pacific Province of the Holarctic Region.

A single glance at the list in the table following will suffice to convince us that the avifauna of the arctic portions of the two North Pacific coasts is essentially the same. Of the 18 species characteristic of the northern part of the Pacific and occurring in those portions of the Eurasian tundra near Bering Strait, not less than 17, and very likely all inhabit the coasts of the Arctic Ocean on the eastern side of Bering Strait. This strait itself therefore in no wise represents a zoögraphic boundary, and it thus becomes impossible to distinguish, at least for the arctic zone, a palaearctic region and a nearctic region. It seems to me likewise obvious that because of the uniformity of the Siberian and the American parts of the tundra on the one hand, and the probable union of these parts at a time relatively recent on the other, their fauna is less differentiated.

The boreal fauna of these regions, on the contrary, exhibits a very much more marked difference in a comparison of its Asiatic and American components. The Northern Pacific Ocean, Bering Sea properly speaking, that washes the neighboring (subarctic) parts of the tundra, is inhabited in the first place by a series of species whose range includes both the Asiatic and the American islands and coasts; these are as follows:

Plectrophenax nivalis townsendi Ridgway
Montifringilla griseinucha (Brewster)
Uria troille californica Bryant
Pseuduria (=Cepphus) carbo (Pallas)
Brachyrhamphus brevirostris (Vigors)
Ciceronia (=Aëthia) pygmaea (Gmelin)
Ceratorhyncha monocerata (Pallas)
Rissa brevirostris Bruch
Sterna aleutica Baird
Ochthodromus mongolus (Pallas)
Arquatella (=Calidris) ptilocnemis (Coues)
Falco peregrinus pealei Ridgway
Branta canadensis hutchinsii (Richardson)
Phalacrocorax bicristatus (Pallas)
Oceanodroma hornbyi (Gray)
Oceanodroma furcata (Gmelin)
Diomedea albatrus Pallas
Diomedea nigripes Audubon

In the second place, the northern Pacific is inhabited by species that are confined either to the Asiatic coasts and islands (chiefly the Commander Islands) or to the American coasts and islands (chiefly the Aleutian Islands); namely:

Boreal Species of the North Pacific.

Asiatic Species	*American Species*
Corvus corax behringianus Dybowski	
Calcarius lapponicus coloratus Ridgway	Calcarius lapponicus alascensis Ridgway
Anothura pallescens Stejneger	Anothura alascensis (Baird)
Brachyrhamphus perdix Stejneger	Brachyrhamphus marmoratus (Gmelin)
	Ptychorhamphus aleuticus (Pallas)
	Larus nelsoni Henshaw
Lagopus lagopus ridgwayi Stejneger	Lagopus rupestris nelsoni Stejneger
Haliaëtus (=Haliaëtus) hypoleucus Ridgway	Lagopus rupestris atkhensis Turner
Phalacrocorax perspicillatus (Pallas) (extinct)	Lagopus rupestris townsendi Elliot
	Lagopus rupestris evermanni Elliot

For the further characterization of this province we may refer also to the representatives of the mammalian fauna of these countries. The species of the genera *Ursus, Ovis, Rangifer, Citellus, Marmota*, and *Arctocephalus* show a very close affinity as between the forms proper to Alaska on the one hand, and those of the east coast of the Chukchi peninsula and the northern part of Kamchatka on the other; they differ from the forms inhabiting the Sibero-American Province as well as from those native to the more central parts of America. It may be added further that the Commander Islands have a local form of Arctic Fox, *Alopex lagopus behringensis* (Merriam) and that in former times the seas about this archipelago were inhabited by *Hydrodamalis stelleri* (Pallas), Steller's Seacow. The fauna of the boreal zone proper differs very much more as regards its Siberian and American portions; for the Siberian portion comprises in addition a series of species belonging to Eurasian genera and the American includes representatives of nearctic genera. All these facts give me sufficient ground for treating the North Pacific as a special zoögraphic subregion, bounded on the west by the Chaun Bay region of the north coast of the Chukchi peninsula, on the east probably by Point Barrow, Alaska, and on the south by the southern edge of the arctic zone (the tundra). The lack of precise data makes me hesitate to set the exact eastern limit of this province, particularly as I am confident that certain species characteristic of it extend beyond Point Barrow.

H.—Species Characteristic of the Nearctic Part of the Holarctic Region.

It is plain that the nearctic species not belonging altogether to the fauna of the North Pacific province, occur in the regions of the Eurasian tundra for the most part only acci-

Distribution of Nearctic Species through

	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Bolschesemelskaja tundra
1. *Arctic Species*	I	II	III	IV	V	VI
1. Saxicola (=Oenanthe) oenanthe leucorrhoa (Gmelin)	+	—	—	—	—	—
2. Larus leucopterus Faber (=glaucoides Meyer)	?err.	—	?hib.	—	—	—
3. Heteropygia (=Calidris) fuscicollis (Vieillot)	—	—	—	—	—	—
4. Pelidna (=Calidris) alpina sakhalina (Vieillot)	—	—	—	—	—	—
5. Cygnus (=Olor) columbianus (Ord)	—	—	—	—	—	—
6. Chen hyperboreus hyperboreus (Pallas)	?err.	—	—	—	—	—
7. Urinator (=Gavia) immer (Brünnich)	err.	err.	hib.	—	—	*
2. *Boreal Species*						
8. Aegiothus (=Acanthis) hornemanni hornemanni (Holboell)	err.	—	—	—	—	—
9. Junco hyemalis (Linné)	—	—	—	—	—	—
10. Seiurus noveboracensis (Gmelin)	—	—	—	—	—	—
11. Dendroica coronata (Linné)	—	—	—	—	—	—
12. Hylocichla minima aliciae Baird	—	—	—	—	—	—
13. Surnia ulula caparoch (Müller)	—	—	—	—	—	—
14. Charadrius dominicus dominicus Müller	—	—	—	—	—	—
15. Aegialitis (=Charadrius) semipalmatus (Bonaparte)	—	—	—	—	—	—
16. Numenius borealis (Forster)	—	—	—	—	—	—
17. Macrorhamphus griseus scolopaceus (Say)	—	—	—	—	—	—
18. Tringoides (=Tringa) macularius (Linné)	err.	—	—	—	—	—
19. Tryngites subruficollis (Vieillot)	—	—	—	—	—	—
20. Grus (=Megalornis) canadensis Gmelin	—	—	—	—	—	—
21. Pelionetta (=Oidemia) perspicillata (Linné)	—	—	—	—	—	—
22. Urinator (=Gavia) arcticus pacificus (Lawrence)	—	—	—	—	—	—
23. Pedetaithya (=Podiceps) griseigena holboelli (Reinhardt)	—	—	—	—	—	—
*=Species that breed regularly	—	—	—	—	—	—
+=Species that breed in limited numbers	1	—	—	—	—	—
trsv.=Species recorded on migration	—	—	—	—	—	—
hib.=Species that winter in the adjacent parts of the Arctic Ocean	—	—	2	—	—	—
err.=Species of accidental occurrence	5	1	—	—	—	—
Total number	6	1	2	—	—	—

dentally; and that only a very limited number of these have been found to breed there. The table following shows us that some of these species reach the Eurasian tundra from the side of the Atlantic Ocean, occasionally wandering not only to Spitzbergen or the latitudes of the Murman coast, but even to Nova Zembla and the Franz Josef archipelago. The great majority of the species, however, come from western America and for the most part do not extend their range in the Eurasian tundra beyond the north coast of the Chuckche peninsula and Wrangel and Herald Islands.

the Eurasian Part of the Holarctic Region.

Vaigach Island	Nova Zembla		Franz Josef Archipelago	Kara Sea, Yamal, and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast of Chukchi Peninsula
VII	VIII a	VIII b	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	err.	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	trsv.	—	*
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?
—	—	—	—	—	—	—	—	err.	err.	rr.+	—	err.	err.	—	*
—	err.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	—	err.	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	err.
—	—	—	—	—	—	—	—	—	—	—	—	*	*	—	*
—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	4
—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	2–3?
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	2	—	1	—	—	—	—	1	1	—	—	1	2	—	9
—	2	—	1	—	—	—	—	1	1	1	—	2	5	—	15–16?

5.—*Accidental occurrence of birds in different sections of the Eurasian tundra.*—It remains for me to devote a brief space to the subject of the accidental occurrence of birds in high latitudes. From a single glance at the list which follows it is obvious that of the entire extent of the Eurasian tundra, it is chiefly from the extreme eastern and western portions that the greatest number of accidental visitors has been recorded. This fact is readily explained in the first place through the greater number of scientific expeditions that have wintered at Spitzbergen and Nova Zembla, and by the extended stay of so

Accidental Occurrences of Birds in the Eurasian Tundra.

	Spitzbergen	Bear Island	Kola Peninsula	Kanin Peninsula	Kolguev Island	Mouth of Pechora	Vaigach Island	Nova Zembla	Franz Josef Archipelago	Kara Sea, Yamal, and Ob	Mouth of Yenisei	Western Taimyr	Eastern Taimyr	Mouth of Lena	Mouth of Yana	New Siberian Archipelago	De Long Archipelago	Mouth of Indigirka	Mouth of Kolyma	Wrangel and Herald Islands	North Coast Chuckche Peninsula
Section	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
Number of accidental species.....	32	17	22	2	10	2	—	22	11	3	7	5	4	5	3	8	1?	2	12	8	33

distinguished and experienced an explorer as B. Kapustin at Yokanga on the Murman coast. As to the extreme eastern regions, the lands adjoining Bering Strait have been more frequently visited by explorers than the more distant parts of the arctic Siberian coast. But apart from these reasons, the relatively large number of accidental occurrences in these regions is to be explained for the western countries by the influence of the Gulf Stream and for the eastern countries by the fact that along the Asiatic coast of the Pacific Ocean lies a much-frequented route of bird migration that doubles Cape Deschneff and continues along the north coast of the Chuckche peninsula.

The list following enumerates the species of birds that have been found to occur accidentally at Spitzbergen, Bear Island, the Murman coast and on the west coast of the southern island of Nova Zembla influenced by the Gulf Stream.

On analyzing this list, we see that of the total number of 29 species of birds that have wandered to Spitzbergen influenced by the Gulf Stream, six species—*Aegiothus* (=*Acanthis*) *hornemanni hornemanni* (Holboell), *Larus leucopterus* Faber (=*glaucoides* Meyer), *Tringoides* (=*Tringa*) *macularius* (Linné), *Chen* sp.?, *Histrionicus histrionicus histrionicus* (Linné) and *Urinator* (=*Gavia*) *immer* (Brünnich)—have reached Spitzbergen from the American coast, thus indicating the former existence of a connection between Greenland and the Spitzbergen archipelago; in the next place *Rhodostethia rosea* (Macgillivray) could only have come from the region of the Franz Josef archipelago; *Urinator* (=*Gavia*) *adamsi* (Gray) probably from its wintering grounds in the neighboring parts of the Barenz Sea; while the 21 remaining accidental species are of European origin, from northern Norway in part, but also from the British Isles.

Those species of birds that have occurred accidentally on the eastern part of the Murman coast (Yokanga) fall into two groups: (1) birds of passage that have appeared in high

Birds of Accidental Occurrence in the Sections of the Eurasian Tundra influenced by the Gulf Stream.

	Spitzbergen	Bear Isl.	Murman Coast	Nova Zembla
1. Corvus corax corax Linné	X	—	resident	X
2. Corone (=Corvus) cornix cornix (Linné)	X (16 May)	X	X	X
3. Trypanocorax (=Corvus) frugilegus frugilegus (Linné)	X(16 May)	—	X (8, 16 Apl.)	X
4. Sturnus vulgaris intermedius Prazak	—	—	X(11 May)	—
5. Sturnus vulgaris subsp.?	—	X	—	—
6. Aegiothus (=Acanthis) hornemanni hornemanni (Holboell)	X	—	—	—
7. Aegiothus (=Acanthis) hornemanni exilipes (Coues)	—	—	nests	X
8. Loxia curvirostra curvirostra Linné	—	X	—	—
9. Passer domesticus domesticus (Linné)	—	—	X(30 Oct.; 15 Nov.)[1]	X
10. Passer montanus montanus (Linné)	—	—	X(21 May; 16 Je.)	—
11. Pyrrhula pyrrhula pyrrhula (Linné)	—	—	X(7 Dec.; 10 Oct.)	—
12. Alauda arvensis arvensis Linné	—	—	X(25 Jan.; 4 Apl.)	—
13. Budytes flava flava (Linné)	—	—	X(20–21 May)	—
14. Anthus spinoletta littoralis (Brehm)	—	X?	nests	—
15. Periparus (=Parus) ater ater (Linné)	—	—	X(20 Oct.	—
16. Aegithalos caudatus caudatus (Linné)	—	—	X(14 Oct.)	—
17. Hedimela atricapilla atricapilla (Linné) (=Muscicapa hypoleuca (Pallas))	—	—	X(18 May)	—
18. Turdus pilaris Linné	X	—	nests	—
19. Turdus iliacus Linné (=musicus Linné)	X	X	nests	—
20. Merula merula merula (Linné)	—	X	—	—
21. Saxicola (=Oenanthe) oenanthe oenanthe (Linné)	—	—	nests	X (rarely nests, north isle)
22. Phoenicurus phoenicurus phoenicurus (Linné)	—	—	X(18 May)	—
23. Hirundo rustica rustica Linné	X sp.?	—	X	X
24. Cypselus (=Apus) apus apus (Linné)	X	—	X(25 Aug.)	—
25. Coracias garrulus garrulus (Linné)	—	—	—	err.
26. Upupa epops epops Linné	X	—	—	—
27. Megalestris catarrhactes (Linné) (=Stercorarius skua (Brünnich))	X	X	X	X
28. Larus marinus Linné	—	X	nests	—
29. Larus argentatus antelius Iredale	—	—	hib.	X
30. Larus argentatus argentatus Pontoppidan	—	?X	—	—
31. Larus leucopterus Faber (=glaucoides Meyer)	X?	—	X?	X
32. Rhodostethia rosea (Macgillivray)	X?	—	—	—
33. Sterna hirundo hirundo Linné	—	—	X	—
34. Haematopus ostralegus Linné	X	X	nests	—
35. Squatarola helvetica (Linné) (=squatarola (Linné))	—	—	X	X
36. Charadrius pluvialis Linné (=apricarius Linné)	—	X	nests	X
37. Eudromias (=Charadrius) morinellus (Linné)	X?	—	nests	nests
38. Numenius phaeopus (Linné)	nests rarely	X	nests	—
39. Tringoides (=Tringa) macularius (Linné)	X	—	—	—
40. Tringa (=Calidris) canutus canutus Linné	X	—	X trsv.	—
41. Scolopax rusticola rusticola Linné	X	—	—	—
42. Grus (=Megalornis) cinerea subsp.?	—	—	—	X
43. Rallus aquaticus aquaticus (Linné)	err.	—	—	—
44. Turtur (=Streptopelia) turtur turtur (Linné)	—	—	X(11 Oct.) young bird	—
45. Aesalon (=Falco) aesalon (Tunstall)	X	X	nests	nests

[1] With the augmentation of the number of houses in the most northern settlements of the Kola peninsula, as Murmansk and Alexandrovsk, the House Sparrow appeared there more frequently (Feduslin, Mem. of the Univ. of White Russia, 1925, nos. 8–9–10, in Russian).

Birds of Accidental Occurrence in the Sections of the Eurasian Tundra influenced by the Gulf Stream—Cont'd.

	Spitzbergen	Bear Isl.	Murman Coast	Nova Zembla
46. Cygnus sp.? (probably C. cygnus)	X	—	nests	X
47. Cygnus bewickii bewickii Yarrell	X	—	X	nests
48. Chen sp.?	X	—	—	—
49. Rufibrenta (=Branta) ruficollis (Pallas)	—	—	—	X
50. Anser erythropus (Linné)	—	—	nests	X
51. Mareca (=Anas) penelope (Linné)	X	X	nests	X
52. Dafila (=Anas) acuta (Linné)	X	X	nests	—
53. Nettion (=Anas) crecca (Linné)	X	X	nests	X
54. Heniconetta (=Polysticta) stelleri (Pallas)	—	—	nests	X
55. Histrionicus histrionicus histrionicus (Linné)	X	—	X	—
56. Mergus albellus (Linné)	—	—	X	X
57. Sula (=Moris) bassana (Linné)	—	—	X	—
58. Urinator (=Gavia) arcticus arcticus (Linné)	—	—	nests	X
59. Urinator (=Gavia) immer (Brünnich)	X	X	winters	X
60. Urinator (=Gavia) adamsi (Gray)	X	—	winters	nests
61. Pedetaithya (=Podiceps) griseigena griseigena (Boddaert)	X	—	—	—
Total number	29	17	24	22

latitudes during their migration periods; and (2) representatives of the forest fauna that have strayed into these countries in the course of their winter wanderings.

Hitherto it has been customary to explain cases of the accidental occurrence of birds as chiefly due to certain storms, which having seized the birds during their migrations, carry them away and then set them down in some locality outside the area of their normal distribution. But the very remarkable fact that it is primarily those arctic areas strongly influenced by the Gulf Stream that show the greatest number of accidental species, prompts me to suggest the theory that it is not only the storms that are responsible for the casual appearances of such birds, but probably also these latter during their spring migrations or in those of early autumn (young birds particularly) are misled by the warmth of the climate in the regions of the Gulf Stream's currents and following these, they may reach Spitzbergen or even the southern island of Nova Zembla. For example, I feel almost convinced that the two Starlings found, the one on Bear Island, the other on the Murman coast, must have wintered in England and wandered to those localities during their spring migration. Likewise, two species—*Merula merula merula* (Linné) recorded from Bear Island, and *Scolopax rusticola rusticola* Linné found in Spitzbergen—could only have come from Great Britain for they are not found in northern Norway. Finally Kapustin's capture of a young Turtle Dove, *Turtur* (=*Streptopelia*) *turtur turtur* (Linné) at Yokanga, 11 October, can only be explained on the supposition that it had been hatched in England, and on leaving its native land, deceived by the high temperature of the latitudes influenced by the Gulf Stream, had doubled North Cape, followed

the southern branch of this warm current and reached Yokanga on the Murman coast. So too, the Swift, *Cypselus* (=*Apus*) *apus apus* (Linné), taken 25 August at Swjatoi Nos, after leaving its native land, mistook the direction and instead of proceeding southward, followed the Gulf Stream to the eastward and so reached the Murman coast. In no case can we admit that the specimen of Skylark, *Alauda arvensis arvensis* Linné, secured by Kapustin 25 January 1925, had reached Yokanga, on the Murman coast passing through the immense snow-fields of northern Russia. It is quite evident that, coming probably in autumn from England, it had doubled the North Cape and following the direction of the Gulf Stream finally reached Yokanga in the last days of January. The influence of the Gulf Stream may be remarked in like manner for a considerable list of species proper to the forest region, which, changing their ground at the approach of the cold season, make their way to Lapland, occasionally going, not toward the south, but in the opposite direction where they experience the milder climate of the countries affected by the warm current. In no other way can we explain the occurrence at Yokanga, on the Murman coast, of such birds as *Passer domesticus domesticus* (Linné), *Pyrrhula pyrrhula pyrrhula* (Linné), *Periparus* (=*Parus*) *ater ater* (Linné), and *Aegithalos caudatus caudatus* (Linné) in the months of October, November and December.

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PLESKE ON BIRDS OF THE TUNDRA

HELIOTYPE CO. BOSTON

PLATE 18.

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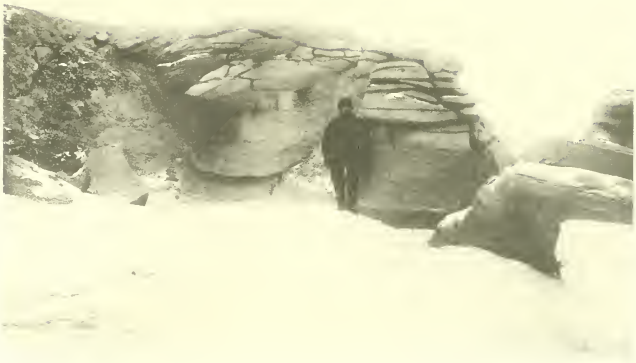

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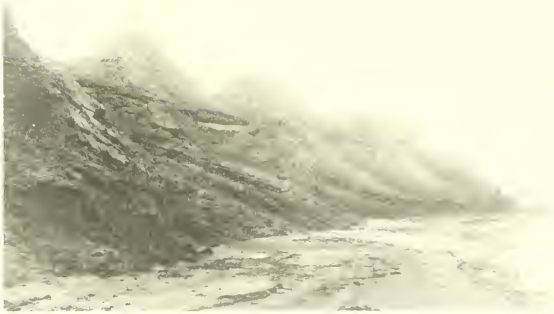

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PLATE 24.

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PLATE 25.

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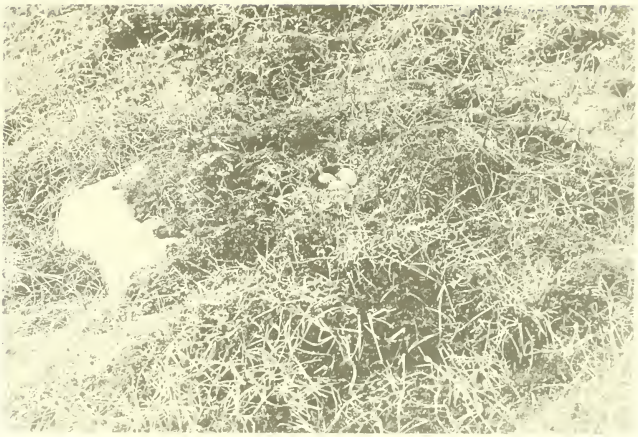

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HELIOTYPE CO. BOSTON

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Fig. 2. Nest of the Brant Goose, *Branta bernicla bernicla* (Linné), on Bonnevie Island, Taimyr peninsula.

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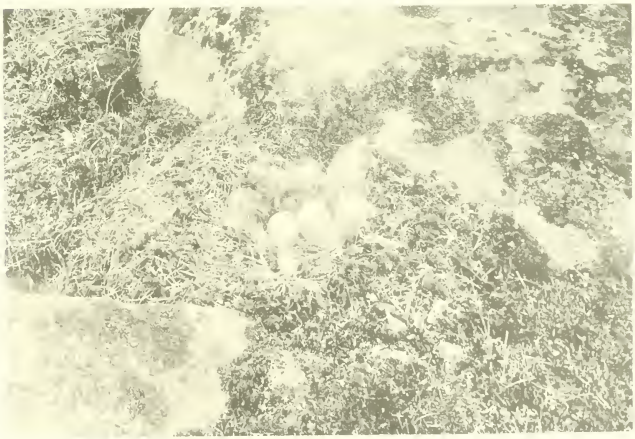

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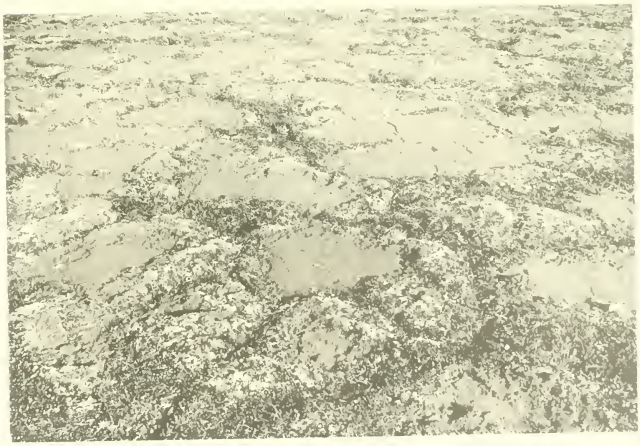

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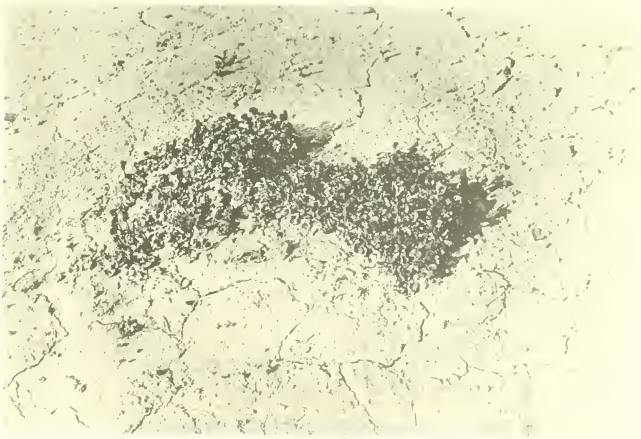

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PLATE 31.

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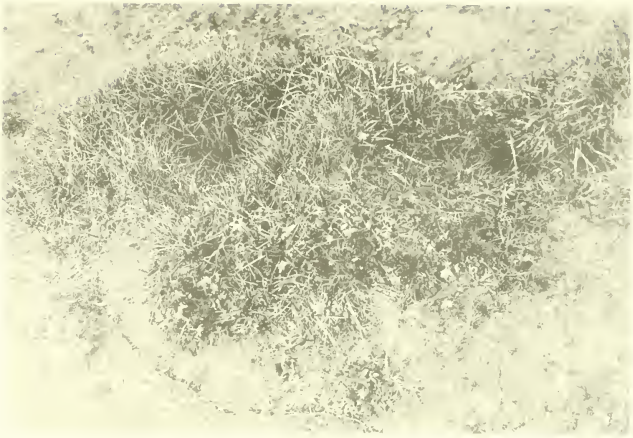

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(Water-color by B. Watagin.)

Pleske on Birds of the Tundra.

PLATE 34.

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Pleske on Birds of the Tundra.

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PLESKE ON BIRDS OF THE TUNDRA.

PLATE 36.

Young in down of the Knot, *Tringa* = (*Calidris*) *canutus canutus* Linné. (Water-color by B. Watagin.)

Pleske on Birds of the Tundra.

PLATE 37.

The eight eggs in the two first (left-hand) vertical columns and the upper two in the third (right-hand) column are of the Knot, *Tringa* (= *Calidris*) *canutus canutus* Linné; the two lower in the third (right-hand) column are of the Turnstone, *Arenaria interpres* (Linné).

PLESKE ON BIRDS OF THE TUNDRA.

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Pleske on Birds of the Tundra.

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Gross on the Heath Hen.

PLATE 39.

Male and female in natural colors. Male in a characteristic pose of "drumming." Colored plate by the late Louis A. Fuertes.

Memoirs of the Boston Society of Natural History.
Volume 6, Number 4.

THE HEATH HEN.

By ALFRED O. GROSS, Ph.D.
(Bowdoin College, Brunswick, Maine.)

WITH TWELVE PLATES.

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Introduction.

In the history of the animal kingdom, species of animals that have been unable to adapt themselves to the changing conditions of their environment have become extinct. Even within the memory of man, species of birds that at one time were eminently successful in their competition for existence have completely disappeared.

The Heath Hen or Eastern Pinnated Grouse is today on the verge of extinction. The only living representatives of this race are on Martha's Vineyard, an island lying off the southeastern coast of Massachusetts. In prehistoric times the common ancestors of the Heath Hen and its near relative the Prairie Hen of the Middle-West prairies, probably ranged in an uninterrupted distribution from the Atlantic seaboard to the plains east of the Rocky Mountains. Later the birds of the East became separated from those of the Middle West and this isolation resulted in the establishment of two races: *Tympanuchus cupido cupido*, the Heath Hen; and *Tympanuchus cupido americanus*, the Prairie Hen.

When the first colonists came to our shores the Heath Hen was abundant in many places in New England and the Middle Atlantic States but it was unable to adapt itself to the new conditions imposed by civilization. It was soon driven out from place after place and by the middle of the nineteenth century it was forced to entrench in its last stronghold on Martha's Vineyard. There on the sandy scrub-oak plains in the central portion of the island, the Heath Hen has up to the present withstood the encroachments of man. It is, however, now waging what appears to be a losing fight for existence. Because of this struggle the Heath Hen has stimulated a great human interest among sportsmen, ornithologists and bird lovers all over the world. Since the Heath Hen can never be of great economic importance, it is purely a matter of sentiment that has prompted the citizens of the Commonwealth of Massachusetts to insist that every reasonable effort be made by the Department of Conservation to assist this bird. Ornithologists are contributing their services and many interested persons have given liberally to the Federation of New England Bird Clubs, Inc., and other organizations to aid in the efforts to prolong the life of the eastern representatives of this unique species.

At this time it is idle to predict the future of the Heath Hen but it is probable that under the present efficient methods of protection the birds will continue to exist for many years, alternately rising and falling in numbers but finally flickering out. From a biological point of view it would be nothing short of the miraculous if the present small group of Heath Hen, chiefly males, fighting against seemingly insurmountable odds, should be able permanently to re-establish itself over any considerable part of its former range in New England.

We know comparatively little concerning the birds that are extinct and hence it is highly desirable to obtain all the information possible concerning this vanishing race before the opportunity is lost. The chief objective of this paper is to compile the more important historical facts concerning the Heath Hen, to discuss the problems of its conservation and to present the results of a study of this bird made in the field and laboratory. In the historical account frequent quotations are made from original sources to enable the reader to form a personal opinion and to arrive at his own conclusions concerning the various phases of the Heath Hen problem.

I wish to acknowledge the help of Dr. John C. Phillips who from the very beginning has taken an intense interest in this problem. I am indebted to the Museum of Comparative Zoölogy, Cambridge, Massachusetts, for the use of its library and extensive collection of specimens; to the Division of Fisheries and Game of Massachusetts for its coöperation, in providing facilities for field work at the reservation, and for the loan of State documents, reports, and correspondence relative to the Heath Hen; and to Dr. Glover M. Allen who has contributed notes on a comparative study of the skeleton of the Heath Hen and Prairie Hen.

I wish to express my gratitude to the late Louis Agassiz Fuertes who painted and contributed the beautiful colored plate of the male and female Heath Hen used as a frontispiece; and to the Federation of New England Bird Clubs, Inc., which provided the funds for its reproduction and also contributed toward the expense of the heliotype plates.

Historical.

Early History.—The Heath Hen is among the first of the American birds to be mentioned in the writings of the early colonists who came to our shores. There is, however, such a dearth of material concerning the Heath Hen during these early times that we know but little of the conditions under which it existed and the records are so incomplete that we are unable to determine with any degree of accuracy its relative abundance and distribution prior to the nineteenth century. These birds were distributed from Maine and Massachusetts to Virginia and possibly the Carolinas according to the statements of the earlier writers on ornithology. They were by no means uniformly distributed over this region but were restricted to certain areas whose features and productions were suitable for their existence. There were large, heavily timbered areas in these States that probably were never visited by the Heath Hen. It was chiefly on the sandy scrub-oak plains of Massachusetts, Connecticut, Long Island, New York, New Jersey and Pennsylvania that they existed in large numbers when white men first came to America.

The earlier writers, of course, did not distinguish the Eastern Pinnated Grouse or Heath Hen from the Western Prairie Chicken, a difference which was only called to our attention in 1885, by William Brewster. At that time the Heath Hen or eastern form had ceased to exist except on Martha's Vineyard whence Brewster secured specimens for comparison with the western form of Pinnated Grouse or Prairie Chicken which he described. I have been unable to locate any museum specimens of Heath Hen from localities other than Martha's Vineyard and Nashawena Island. It is probable that the birds which existed in other parts of New England were the eastern form but we have no proof that birds from other parts of the range remote from Martha's Vineyard, as those of Pennsylvania, were of this subspecies. Ornithologists of today do not consider the differences between the Heath Hen and the Prairie Chicken sufficient to warrant the recognition of two species, but consider them geographical representatives (or subspecies) of a single species even though the birds in the vast intermediate region have been exterminated. The details concerning the status of these two forms are fully discussed in another section of this paper.

Some of the earlier American writers designated the Heath Hen by the name of Heathcocke, Pheysant and Grous but their notes and descriptions are such that they can be clearly referred to this species. The early references usually treat of the birds as objects of curiosity rather than from a scientific point of view but these early notes are nevertheless of great interest to us from an historical standpoint. In 1635 William Wood (p. 29) in his New England's Prospect mentions the abundance of certain Hawks

which were destructive to poultry, Partridges, Heathcockes and Ducks. On another page he writes: "Heathcocke and Partridges be common: he that is husband, and will be stirring betime, may kill halfe dozen in a morning. The Partridges be bigger than they be in England, the flesh of the Heathcockes is red, and the flesh of the Partridge white, their price is four pence a piece." Wood resided at what is now the city of Lynn in Massachusetts. His map included Cape Ann and the Merrimack River, hence it is evident the Heath Hen existed in northeastern Massachusetts in his day.

In 1637 Thomas Morton (p. 193) wrote: "There are a kind of fowles which are commonly called Pheysants but whether they be Pheysants or no, I will not take it upon me to determine. They are in forme like our Pheysant henne of England. Both the male and female are alike: but they are rough footed and have stareing feathers about the head and neck; the body is as bigg as the pheysant henne of England; and are excellent white flesh and delicate white meate yet we seldom bestowe a shoote at them." Morton, it is generally believed, referred to the Heath Hen although the Heath Hen has dark, not white, flesh.

On August 26, 1644, the Rev. Johannes Megapolensis, Jr. (Jameson, 1909, p. 169) sent a letter out from New Netherlands in which he wrote, "There are many partridges, heath-hen and pigeons." In 1639, David Pieterszoon de Vries stated that the Heath Hen was common in New Amsterdam and at Fort Orange, Albany. In 1680, William Hubbard (p. 672), including events from 1635 to 1650 in a brief account of New York, stated: "Wild fowl there is a great store of, as turkeys, heathhens, quails, partridges, pigeons, cranes, geese of several sortes, brants, ducks, widgeon, teal and divers others." These notes definitely establish the distribution of the Heath Hen in the region from Massachusetts to New York in the early colonial days but it is more difficult to determine for a certainty the former existence of these birds in other parts of the range, especially the Carolinas and Maine.

Mark Catesby includes the Heath Hen in the appendix (vol. 2, p. 1) of his notable work on American birds, Natural History of Carolina, Florida and the Bahamas, which appeared in two volumes in 1731–43. Catesby's work contains the first published picture of the Heath Hen. He, however, did not see the Heath Hen in America during his visits here in 1710–19 and again in 1722–26. It was not until he returned to England in 1743 that he saw them at Cheswick, the seat of the Earl of Wilmington. The birds came from America but the exact locality was not known, hence the listing of this bird for the region covered by Catesby is of less significance in establishing Carolina as a part of its former range. John Latham in his General Synopsis of Birds (1783, vol. 2, p. 740) includes Carolina within the range of the Heath Hen and James Stephens stated in his General Zoölogy (1819, p. 299) that "the Heathcocke is found in Carolina." These and

other writers following Catesby may have erroneously copied his record but we have no way of knowing the source of their information. William Brewster states that he never found that it occurred south of Pennsylvania but I cannot see that he has disproved the statements of Latham and Stephens. It is true we have no specimens that were collected in Carolina but neither have we skins from any part of its former range outside the islands off the coast of Massachusetts. It is apparent that if the Heath Hen did exist in Carolina it was extirpated from that section of its range at an early date.

There seems to be less doubt concerning the occurrence of the Heath Hen in Virginia. A writer who signs his initials S. C. C. (Forest and Stream, 1882, p. 344) states: "The Heathcockes as they were called occurred as far south at least as Virginia." An early work called A Perfect Description of Virginia (London, 1649) mentions among other birds of that Plantation the "Heathcocke." The late C. S. Westcott of Philadelphia (Grinnell, 1910, p. 211) stated that it occurred (according to tradition) in Maryland and Delaware on the shores of Chesapeake Bay and on the peninsula of Maryland and Virginia. The bird described by Linnaeus in 1758 was said to have come from Virginia and he states in his Systema Naturae (1758, ed. 10, vol. 1, p. 160) that its habitat is Virginia. It is therefore reasonable to infer that Virginia, as it existed in colonial times, was a part of the former range of the Heath Hen. It has also been known to exist in Washington, D. C. (Swales, 1919, p. 198).

There is some doubt as to the existence of the Heath Hen in Maine, the supposed northern limit of its former range. Charles L. Bonaparte in his Genera of North American Birds (1826–28, p. 127) includes Maine within the range of the Heath Hen. Audubon (1842, p. 95) stated that the Heath Hen were still met with on "Mount Desert Island in the State of Maine, and a certain tract of barreny country in the latter State, lying not far from the famed Mar's Hill, where, however, they have been confounded with the Willow Grouse." Baird, Brewer and Ridgway (1874, p. 443), commenting on Audubon's Maine records, stated: "In regard to the occurrence of the Heath Hen on Mount Desert Island and in another tract of barren country near Mar's Hill Audubon may have been misinformed." Some ornithologists are of the opinion that the so-called Heath Hen found at Mar's Hill were probably the Spruce Partridge, *Canachites canadensis*. James E. DeKay (1844, p. 205) and Baird, Cassin and Lawrence (1860, p. 629) and others who followed, included Maine in the geographical range of the Heath Hen. We have no grounds on which to question these statements as well as those of Bonaparte although they have been generally ignored. Since the Pinnated Grouse is found in the Canadian Northwest it is not beyond the range of possibility that it once occurred in Maine. It is interesting to note that in 1876–78 the Pinnated Grouse was protected from January 1 to September 1 by the Acts and Resolves of the 55th Legislature of Maine

(p. 71) and of the 57th Legislature of Maine (p. 45). The Pinnated Grouse was later introduced into the State (Forest and Stream, 1888, vol. 31, p. 453). It is unfortunate that the records are so uncertain and obscure that we cannot definitely establish the former range of the Heath Hen. Its disappearance from the different sections of its former range is also enshrouded with uncertainty. In New Hampshire according to Belknap (1792, p. 171) the "Growse" (probably Heath Hen) still existed but was rare in 1792. There is a hill near Manchester, New Hampshire, called Heath Hill which I am told was a former resort of these birds. I have been unable to find any records for New Hampshire other than the uncertain one given by Belknap.

In early colonial days Heath Hen were very abundant in certain sections of the mainland of Massachusetts. In 1840 Thomas Nuttall (p. 800) wrote: "According to the information which I have received from Lieut. Governor Winthrop, they were so common on the ancient bushy site of the city of Boston, that laboring people or servants stipulated with their employers not to have *Heath-Hen* brought to table oftener than a few times in the week." I have not been able to find statements concerning the relative abundance of the birds in other sections of the mainland of Massachusetts but doubtless they were common in districts providing a suitable environment. By the beginning of the nineteenth century it was a rare experience to see them on the mainland. William Brewster, quoting from an autobiographical sketch by J. E. Cabot (1904, p. 94) states that "Mrs. Elizabeth Cabot saw a prairie grouse (Heath Hen) in Newton about the beginning of the nineteenth century and one down to the Cape (probably Cape Cod) about 1812." They disappeared from the plains in the Connecticut Valley near Springfield about 1812 or 1813 (Forbush, 1916, p. 387). The last specimen of Pinnated Grouse on the mainland of Massachusetts was killed about 1830 near Northampton, by a well-known sportsman of Boston, according to a note published in Forest and Stream (S. C. C., 1882, p. 344). S. Cabot (1855, p. 154) states a specimen was killed on Cape Cod, but thinks it may have flown over from Martha's Vineyard or Naushon Island. Specimens of Pinnated Grouse were killed at Falmouth on the mainland but Brewster was inclined to believe that these birds were introduced Prairie Chickens. Since we do not have the skins we cannot prove or disprove the statement. It is probable that the birds were gone from the mainland by 1840 for as far as I have been able to determine we have no evidence that they occurred there after that date. The birds lingered on the islands off the coast of Massachusetts for a longer period and of course still survive on Martha's Vineyard. In a letter written December 6, 1832, to Audubon by David Eckley, Esq., of Boston, it is stated: "The Heath Hen are on Martha's Vineyard, one of the Elizabeth Islands, Nashawenna is the only other island of the group where they are found." There is a male specimen Cat. No. 5517 in the museum of the Boston Society of Natural History

collected on Nashawena Island. The catalogue contains in William Brewster's own handwriting the following: "Dr. Arthur Cabot tells me that he is sure his father received this bird in the flesh from Nashawena Island, Massachusetts." In 1855 Dr. S. Cabot (p. 154) mentions the existence of the birds on Nashawena Island. As late as 1876 J. A. Allen (1876, p. 53) in a paper on the "Decrease of Birds in Massachusetts" stated: "A few pairs are still known to exist on the islands of Naushon and Martha's Vineyard where they have been of late stringently protected by law."

In Connecticut as in Massachusetts the early records though meager indicate that the Heath Hen was present in certain districts of the State. In 1785, Thomas Pennant (p. 356) described birds in Blackburn's Cabinet that were collected in Connecticut. As late as 1840, according to Thomas Nuttall (p. 800) they were still to be found on the scrubby plains in Westford, Connecticut. I have not been able to find any later dates of the occurrence of these birds in the State and it is probable that they disappeared from Connecticut very soon after 1840, for Linsley in 1843 stated that the Heath Hen was a bird of the past as far as Connecticut was concerned. Long Island, New York, was one of the former strongholds of the Heath Hen. John Latham in his General Synopsis of Birds (1783, vol. 2, p. 740) states that it was particularly abundant on the brushy plains of Long Island and J. F. Gmelin (1796, p. 434) stated: "et est très-commune a l'île Longue, (près la côte de la Nouvelle-Yorck)." Dr. Samuel Mitchell in a letter dated September 19, 1810, to Alexander Wilson (Wilson, 1832, vol. 1, p. 392) wrote concerning the Heath Hen on Long Island that they "inhabit chiefly the forest range. This district of the island may be estimated as being between forty and fifty miles in length, extending from Bethphage, in Queen's County, to the neighbourhood of the court-house, in Suffolk. Its breadth is not more than six or seven. . . . The region in which these birds reside, lies mostly within the towns of Oysterbay, Huntington, Islip, Smithtown, and Brookhaven; though it would be incorrect to say, that they were not to be met with sometimes in Riverhead and Southampton. Their territory has been defined by some sportsmen, as situated between Hampstead Plain on the west, and Shinnecock Plain on the east. The more popular name for them is Heath-hens. By this they are designated in the act of our legislature for the preservation of them and of other game. . . . The bill was introduced by Cornelius J. Bogert, Esq. a member of the Assembly from the city of New York . . . in the month of February 1791.

"The statute declares, among other things, that the person who shall kill any Heath-hen within the counties of Suffolk or Queens, between the 1st day of April and the 5th day of October, shall, for every such offence, forfeit and pay the sum of two dollars and a half, to be recovered, with costs of suit, by any person who shall prosecute for the same, before any justice of the peace, in either of the said counties; the one half to be paid to the

plaintiff, and the other half to the overseers of the poor; . . . and if any Heath-hen, so killed, shall be found in the possession of any person, he shall be deemed guilty of the offence, and suffer the penalty. But it is provided, that no defendant shall be convicted, unless the action shall be brought within three months after the violation of the law. [Nuttall adds that the "bill was entitled 'An Act for the preservation of Heath-hen, and other game'. The honest chairman . . . read the title, 'An Act for the preservation of *Heathen*, and other game;' which seemed to astonish the northern members, who could not see the propriety of preserving *Indians* or any other Heathen."] In spite of law it was common to disregard it. To prevent unlawful shooting an association called the Brush Club was formed, with the avowed intention of enforcing the law. Little benefit, however, has resulted from its laudable exertions; and under a conviction that it was impossible to keep the poachers away, the society declined. At present the statute may be considered as operating very little towards their preservation. Grouse, especially full grown ones, are becoming less frequent. Their numbers are gradually diminishing; and, assailed as they are on all sides, almost without cessation, their scarcity may be viewed as foreboding their eventual extermination. . . . Twenty years ago, a brace of Grouse could be bought for a dollar. They now cost from three to five dollars. . . . These prices . . . prove . . . that Grouse are become rare; and this fact is admitted by every man who seeks them, whether for pleasure or for profit."

According to William Dutcher (1893, p. 250), Colonel Pike killed a number of birds (Heath Hen) in the plains near Comac Hills in 1836 and made skins of them. No one as far as I know has been able to locate these specimens. Wilson (1832, p. 392) and Audubon (1842, p. 93) both state that at the time of writing the birds were still to be found on the brushy plains of Long Island. James E. DeKay (1844, p. 205) wrote: "In this State [New York], they are now [1844] almost entirely extirpated. The specimen figured in the plate, was one which I had obtained from Long island in 1840, and which was probably the last of his race in that district. . . a few are still said to linger about Orange county in this State." J. P. Giraud (1844, p. 195), also writing in 1844, stated: "On Long Island the 'Prairie Hen' is very nearly if not entirely extinct. Thirty years ago, it was quite abundant on the brushy plains in Suffolk county, which tract of country is well adapted to its habits—but being a favorite bird with sportsmen, as well as commanding a high price in the New York markets, it has been pursued, as a matter of pleasure and profit, until now it is very doubtful if a brace can be found on the Island. On a recent excursion over its former favorite haunts, I could find no trace of it. In conversation with several of the elder residents, they spoke of the 'Heath Hen' as being very abundant some twenty or thirty years since, but now consider it entirely extinct."

The Heath Hen lingered somewhat longer in certain favorable places of New Jersey and

Pennsylvania. Bartram in 1791 mentioned it as a common breeding bird in Pennsylvania. Wilson (1832, p. 392) stated that the Heath Hen were still to be found on the plains of New Jersey, in Burlington County, and among the pines and scrub oaks of Pocano in Northampton County, Pennsylvania. Audubon (1842, p. 559) in his Birds of America wrote that they were still to be found in New Jersey and stated that $100.00 was refused for ten brace of Heath Hen which were shot on the Pocano Mountains in Pennsylvania. Turnbull (1869, p. 35) in his Birds of East Pennsylvania and New Jersey, wrote: "Now very rare. A few are still met with in Monroe and Northampton counties, Pennsylvania, where I have shot the species. Within the last year or two it has also been found on the Jersey Plains." In an editorial note appended to an article by Cornelius Weygandt (1906, p. 19) on the summer birds of Broadhead's Creek, Monroe County, Pennsylvania, it is stated that the huckleberry barrens of that region were one of the last resorts of the Heath Hen which was last seen there about 1869. This note, however, may be based on Turnbull's statement and not on additional sources of information. In a letter written to Dr. Frank M. Chapman (1903, p. 50) on January 31, 1903, concerning the Heath Hen on the plains twelve miles west of Barnegat, New Jersey, George Van Note states: "They bred on the plains and were always found on them. There were lots of them forty years ago." According to Van Note the birds were still on the plains of New Jersey about 1863, which serves to substantiate the statements of Turnbull and others.

In Forest and Stream (1882, vol. 19, p. 309) there is a note signed by "Homo" (C. S. Westcott) which reads as follows: "Frank Forester speaks of the pinnated grouse having been plentiful on Martha's Vineyard and writes of them abounding on Long Island, in Burlington county, N[ew] J[ersey], and on the Pocons plains or barrens in Pennsylvania. I know from natives of Manahawken, N[ew] J[ersey], that so late as fifteen years ago 'grouse,' not ruffed ones or pheasants, were killed not far from that place, and a friend living now in the Lehigh Valley, P[ennsylvani]a, . . . killed 'two strange grouse with very short tails . . . feathered all the way down to the ankles, from a brood of ten or twelve grown birds,' a few years since. The locality where they were shot was but a few miles from the 'barrens' spoken of by Forester."

From the foregoing meager records it may be inferred that the former range of the Heath Hen extended from Massachusetts and New Hampshire and probably Maine, southward through Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia and possibly the Carolinas. It was gone from the mainland of Massachusetts and Connecticut by 1840 but it lingered in parts of New Jersey and Pennsylvania until about 1869. We have no records of native birds on the mainland after this date. A few were found on Nashawena and possibly other of the Elizabeth

Islands besides Martha's Vineyard as late as 1876. By 1880 the surviving members of this interesting race, excepting for subsequent introductions, have been restricted to the Island of Martha's Vineyard.

Martha's Vineyard.—C. E. Banks in his History of Martha's Vineyard (1911, p. 27) writes: "The Heath Hen or Pinnated Grouse has been on the Island for at least a century. It probably was brought here for breeding as a game bird and in 1824 laws for its protection were passed by the voters of Tisbury." We cannot be positive because of conflicting and uncertain statements whether the Heath Hen was native to Martha's Vineyard or introduced there from the mainland after the coming of the white man. In either case it is truly remarkable that the birds after being so greatly depleted in numbers, at such an early date have persisted in this very restricted area where excessive interbreeding has been possible and where the birds have been subjected to many enemies and to various adverse conditions. As was true on the mainland before they were extirpated from there, the birds were ruthlessly persecuted on Martha's Vineyard by thoughtless hunters. The following statements taken from a letter written December 6, 1832, by David Eckley, Esq., of Boston to John James Audubon, concerning the Heath Hen on Martha's Vineyard Island give us a very vivid impression of the methods of hunting and also the hardships endured by the birds at that time. He writes, "Sending a brace of Grouse from Martha's Vineyard, one of the Elizabeth Islands. Nashawenna is the only other island of the group on which they are found. . . . In Fall seldom 'lie to the dog' but are easily started. A high wind which drowns the approach of danger, is the most desirable, a calm drizzly day is also favorable. It is seldom that we start a bird a second time in the exact spot where he has been seen to hover down, for no sooner do they alight than they run, and frequently into thick cover, from which they often attempt in vain to disentangle themselves. A dog is then necessary to scent the bird which alternately runs and squats until being hard pressed, it rises and frequently with a sound which resembles *cac-cac-cac* uttered with rapidity. . . . We frequently meet with the remains of such as have been destroyed by the domestic cat which prowls in the woods in a wild state. . . . Owls, Hawks, and Skunks also do their part towards the destruction of these valuable and defenseless birds. In these ways they are thinned off much more effectually than by the sportsman's gun."

Methods of Hunting.

"In the chosen spots, it is said the cunning natives were accustomed to strew ashes, and rush upon them with sticks when blinded by the dust which they had raised. In later times, the custom of baiting them has proved more destructive to the species. In this way, very great but very unsportsman-like shots have often been made. Another practice has been that of stealing upon them unawares, guided by the peculiar sound

for which they are remarkable in the spring of the year called 'tooting.' They are now protected by an Act of the State of Massachusetts passed in 1831 which limits time of shooting to November and December, and imposes a penalty of ten dollars each bird for all that are killed except in these two months."

The following statement by William Peabody (1839, p. 355) also serves to define the status of the bird and the conditions under which it existed during the early part of the nineteenth century. "The only place where they [Heath Hen] are now found in Massachusetts, is in Martha's Vineyard, and one small island near it; and there, though pains are taken to protect them, they are said to diminish fast, the high price which they command in the market, being a strong temptation to shoot them. Cats, also, which run wild in the island, do their part in the work of extermination. The wonder is, that with all their timidity, they have remained so long, but their patience and their attachment to their old haunts will be wearied out, and other means must be found to gratify the epicure's taste." The following excerpt taken from an article written December 20, 1882, by "Heth-Hen" (Forest and Stream, 1883, p. 467) gives a bit of the early history of the island and the status of the Heath Hen at the time the article was written. "In 1641 one Thomas Mayhew obtained from Lord Sterling a grant, the land now known as Martha's Vineyard and the neighboring islands. In 1642 he sent his only son Thomas, a young man of 21 years who prepared for the ministry, to Martha's Vineyard and he with some others settled at Edgartown. The elder Mayhew soon after came to Edgartown and became Governor of Martha's Vineyard and the adjacent islands. Some years afterward Governor Mayhew sold the island of Naushon (one of the Elizabeth Islands) to Waitt Winthrop. It remained in the Winthrop family some years and was afterward sold to a gentleman named Bowdoin who was afterward Lieut. Governor of Massachusetts. Mr. Bowdoin succeeded in getting a law prohibiting shooting [Heath Hen] on his possession except by special permission. This was 50 years or more ago and the law is still in force. The island [Naushon] has since passed through a number of hands and is now the property of John M. Forbes, Esq., of Boston. It is well stocked with deer but we doubt if there are any Heath Hens there now although some were carried from Martha's Vineyard and placed on the island some years ago. At present time [1882] a good many are killed [on Martha's Vineyard] by persons visiting Oak Bluffs, not that any one person succeeds in getting many, but a good many go after them 'on the quiet' so that more or less are killed every year. The many miles of cover which they have, and the comparative scarcity of the birds, makes it difficult to find them, although when a bevy is found their destruction is easy, for their flight is an open one, and quite different from the shot one gets at an old partridge through the woods. The writer has seen many that were shot."

C. J. Maynard (1882, p. 351) writes as follows: "I learn from my friend, Mr. [H. A.] Purdie, that he has ascertained through reliable sources that there is still quite a little colony of these Grouse living on Martha's Vineyard, but that, in spite of the very stringent laws, enacted by our Legislature, for their protection, some are shot every year. This is certainly deplorable, and the ornithologists of the State ought to make some effort to save these fine birds from the total extermination which will ultimately be their fate unless the law is strictly enforced." It is very apparent that in times past and even to comparatively recent years the local sentiment in favor of the Heath Hens on Martha's Vineyard was not strong enough to enforce the laws prohibiting the shooting of the birds. There was much of this indifference when I first went to the island in 1923. It is very gratifying to know that this attitude has been greatly changed on the part of the better class of people since they realize the great importance of saving these birds from extinction.

According to J. E. Howland (1890, p. 207) there were considerable numbers of the Heath Hen in 1882 when on some days he could start fifteen to twenty of them. Since 1882 he states that he has never seen over a dozen in any one season and during several days' hunting during the preceding year (1889) he failed to see a single bird.

In 1890 the numbers were so greatly reduced that William Brewster (1890, p. 207) estimated that there were not more than one hundred and twenty to two hundred birds on the island. His detailed description of the area occupied by the Heath Hen at that time is of great interest. "Its range extends over practically the entire wooded portion of the island, but the bird is not found regularly or at all numerously outside an area of about forty square miles. This area comprises most of the elevated central portions of the island, although it also touches the sea at not a few points on the north and south shores. In places it rolls into great rounded hills and long irregular ridges, over which are scattered stretches of second-growth, woods often miles in extent, and composed chiefly of scarlet, black, white, and post oaks from 15 to 40 ft. in height. Here and there, where the valleys spread out broad and level, are fields which were cleared by the early settlers more than a hundred years ago, and which still retain sufficient fertility to yield very good crops of English hay, corn, potatoes and other vegetables. Again this undulating surface gives way to wide, level, sandy plains, covered with a growth of bear, chincapin and post oak scrub from knee to waist high, so stiff and matted as to be almost impenetrable; or to rocky pastures, dotted with thickets of sweet fern, bayberry, huckleberry, dwarf sumac and other low-growing shrubs. Clear, rapid trout brooks wind their way to the sea through open meadows or long narrow swamps wooded with red maples, black alders, high huckleberry bushes, andromeda and poison dogwood, and overrun with tangled skeins of green briers."

In 1896, six years after Brewster made his estimate of one hundred and twenty to two hundred birds, Kentwood (1896, p. 343) expressed a doubt if there were one hundred Heath Hen remaining on the island.

Charles E. Hoyle (1901, p. 200), who had unusual opportunities for studying the Heath Hen over a period of twenty years and who collected more specimens of the Heath Hen than any other person, contributed an interesting article to American Ornithology, in which he states: "Its range covers all the barren portion of the Island and it prefers the more open portions to the wooded ones, and seldom takes to the woods unless driven there by inclement weather, lack of food, or enemies. . . . This bird used to be very common on the Island. Old hunters have told me that they have seen as many as two or three hundred birds in a flock. They have gradually dwindled in numbers through being hunted very closely by native hunters, many of the birds finding their way to the Boston and other markets, but a great many more being used at home. I saw a bed tick filled with the feathers from this bird. In 1892–3 men who had watched this bird closely on the Island, stated to me that they had diminished in numbers in the previous five years to about one-quarter what they were previously. In June, 1894, a fire swept over practically all their breeding grounds, and in the Fall of that year I spent two weeks going over their whole ground. We found many skeletons of the birds that had been destroyed in this fire, and where the previous Fall we started up one hundred birds, we did not start up five. Added to these two causes for its diminution in numbers, must be added a third, *i.e.*, the destruction done by foxes. A number of years ago there were no foxes on the Island, but some one thought it would be a good thing to have fox hunts and introduced them. This bird being an easy prey for the fox, a great many were undoubtedly destroyed by this animal. Since 1894 these birds have been very few in number compared with the years previous, and in 1897 they had practically been exterminated or died out. The Fall of that year, I went over the ground again and in one week's time, with good dogs to locate any birds there might be, I did not start a single bird.

"In the Spring of 1898 two mated pairs of western prairie chickens that had been on exhibition in the Boston Sportsmen's Show, were liberated by one of the local sportsmen on the Island. This I am positive of, because I am well acquainted with the man who liberated the birds, and others who saw them. These birds have undoubtedly bred, for in the Fall of that year two broods of young birds were located in the region where the prairie chickens were liberated. The old birds were also seen at various times through the summer in the same locality. Since that time they seem to be gradually gaining in numbers, though they are very few but it is undoubtedly owing to the introduction of these Western birds and their interbreeding with the few that were left."

In connection with Hoyle's remarks concerning the introduction of the Prairie Chick-

ens the following statements by C. H. Hine (1907, p. 73) are of interest: "Mr. Forbes liberated a large flock of Prairie Chickens on Naushon and the following season not one was to be found and it is thought that they flew across the sound and joined themselves unto their eastern cousins. Several small flocks have been brought to the Vineyard direct and allowed to run wild in the hope that they would furnish sport for the gunner." According to George W. Field (1907, p. 249; 1908, p. 57): "In 1902 specimens of the western Prairie Chicken (*Tympanuchus americanus*), which had survived the sportsmen's show at Boston, were liberated on Martha's Vineyard, but no subsequent indications of their presence are known." Since even an expert ornithologist is not able to distinguish a Prairie Chicken from a Heath Hen in the field we would not expect to detect any indication of their presence. If it is true that the western birds have been introduced and have successfully interbred with the Heath Hen it means we do not have a pure race of the Heath Hen on Martha's Vineyard today.

By the beginning of the twentieth century the birds had reached a very low ebb in their existence, a condition brought about not so much by the lack of laws but, as before intimated, by a lack of public interest and sentiment in favor of the Heath Hen, to enforce the laws. New York was the first State to give the Heath Hen protection in 1708 and 1785 and according to T. S. Palmer (1901, p. 82) the only law protecting birds at the beginning of the nineteenth century in force in New York was one protecting the Heath Hen, Ruffed Grouse, Bob White and Woodcock on Long Island and in New York County. New Jersey began to protect Heath Hen in 1820 and Rhode Island in 1846. E. H. Forbush (1907, p. 7) gives us the following account of the laws pertaining to the Heath Hen in Massachusetts. In 1831 the Heath Hen had become so rare in the State that a special act was passed protecting them during the breeding season, or from March 1 to September 1, under penalty of a two-dollar fine. This partial remedy proved entirely ineffective, and the Grouse were soon destroyed and driven out until Cape Cod became their last stronghold on the mainland of Massachusetts. These birds were now disappearing throughout their range in the Atlantic Coast States, and in 1837, after they had disappeared from the mainland, a special statute was passed, establishing a closed season for the Heath Hen for four years, with a penalty of $10 and a forfeit of $10 to the land owner. This was extended five years more in 1841 and in 1844 the fine was increased to $20 in addition to the $10 forfeit to the land owner, and the possession or sale of the birds was forbidden. All these provisions, too late to be effective, were of no avail, except to protect the few left on Martha's Vineyard.

In 1855 all protection was removed from this bird; still for five years the last remnant of the race persisted, unprotected, in the wild and bushy interior of Martha's Vineyard, where they were not much molested. In 1860 they were again protected by law at all

times, under a penalty of $20, but in 1870 the date of such protection was fixed at a period of five years. "These acts," (G. W. Field, 1907, p. 250) "however, permitted any town to suspend this law in that town for such a period as they deemed expedient. Some towns took advantage of this to secure special privileges for the inhabitants of the town, *e.g.* Tisbury, on May 6, 1842, 'voted that the Law for the Preservation of the Grouse or Heath Hen be so far suspended in the Town of Tisbury as to allow the inhabitants of said town to kill, take or sell Grouse or Heath Hens from the first day of December to the tenth day of December inclusive, provided they hunt them without the aid of dogs.' . . . On April 1, 1850, the same town of Tisbury voted to suspend this law so as to permit the hunting (without dogs) of these birds on the '12 and 13 of November next.' . . . From this period to 1905 there were no systematic attempts to enforce the law . . . many birds were killed by rabbit hunters and by duck hunters crossing the island to the ducking stands on the south shore. Some birds were taken by collectors, and these skins, supplemented by others bearing fraudulent data, were disposed of extensively to museums and natural history stores." In a letter written by John E. Howland from Vineyard Haven, Massachusetts, on July 21, 1905, he states as follows: "Some ten years ago there was a craze to get specimens of these birds by collectors and museums, it being understood they would soon become extinct. Large prices were paid, and this was an inducement for the market hunter and others akin to him to go out and hunt them. If a man hunted a week and got one specimen he possibly got $20 for it, so he was working a good thing, and the fine was only $20 if caught. Now the nature of the ground inhabited by these birds makes it almost impossible to trap a fellow who is out to kill them. It is a dead level for miles, and unfortunately directly between the towns of Cottage City and Vineyard Haven, and the duck shooting grounds on the south side of the island." In connection with these last statements it is interesting to note that most of the Heath Hen specimens in existence today (see page 558) were collected by C. E. Hoyle, his agents, and others during the period between 1890 and 1900. This intensive collecting done at a time when the numbers were very low must be considered a very important factor along with other causes, for the low ebb reached by the Heath Hen at the beginning of the twentieth century.

We are indebted to Mr. Howland, who was among the first to call the attention of the Massachusetts Commission of Fisheries and Game and of the National Audubon Society to the conditions existing on Martha's Vineyard. He urged increasing the fine for killing a Heath Hen from $20 to $100 and emphasized the importance of doing anything that would serve to better the sentiment of protection on Martha's Vineyard. Dr. George W. Field, then chairman of the Massachusetts Commission, who has always fostered a great interest in the Heath Hen, quickly responded to Mr. Howland's suggestion and in his an-

nual report for 1905 (p. 61) we find the following: " . . . serious and well-devised attempts to re-establish this bird in sufficient numbers to place it beyond the possibility of extermination should be actively undertaken. First of all, measures should be immediately instituted to rigidly protect the present number (estimated at about 100) for a period of at least five years. Inasmuch as many are now killed by or for collectors, who are willing to pay $20 to $30 for a specimen, the fine for killing, or having in possession a bird of this species killed in Massachusetts, should be at least $100. It is hoped that arrangements for breeding this interesting and valuable bird under the immediate control of this commission may be completed this summer, for the purpose of establishing this bird where it may again become a source of pleasure to the bird lover and to the sportsmen."

The National Association of Audubon Societies in the official organ of the Association, Bird-Lore (1905, vol. 7, p. 329), also called attention to the importance of protecting the Heath Hen, as follows: "There is one important matter that should receive the earnest attention of the Massachusetts public, and especially the members of the Audubon Society; in fact, it is of interest to all persons who care for wild life. The few remaining Heath Hens on Martha's Vineyard will disappear in a short time if a law, making a close season for at least ten years is not passed by the next legislature. The fine should be not less than $100 for killing one of these birds or taking any eggs, and they should have special protection by an efficient warden. The small number left is all that exists anywhere on the globe, and when they pass away another race of birds will be extinct. This colony is fortunately so situated that it can be easily protected, and the experiment of trying to save a species of birds on the verge of extinction will be of great scientific interest. The National Association urges upon the citizens of Massachusetts immediate action, and pledges its influence and help."

In the same year the Biological Survey Bulletin No. 24 of the United States Department of Agriculture contained the following statement concerning the Heath Hen: "If this bird can be saved from extinction and introduced into many of the eastern States it will be much more likely to succeed, on account of its woodland habits and narrow range, than the Prairie Hen, which requires a more open country, and usually does not take refuge in woods from its enemies. Experiments with the Heath Hen must be made soon, however, or it is likely to become extinct."

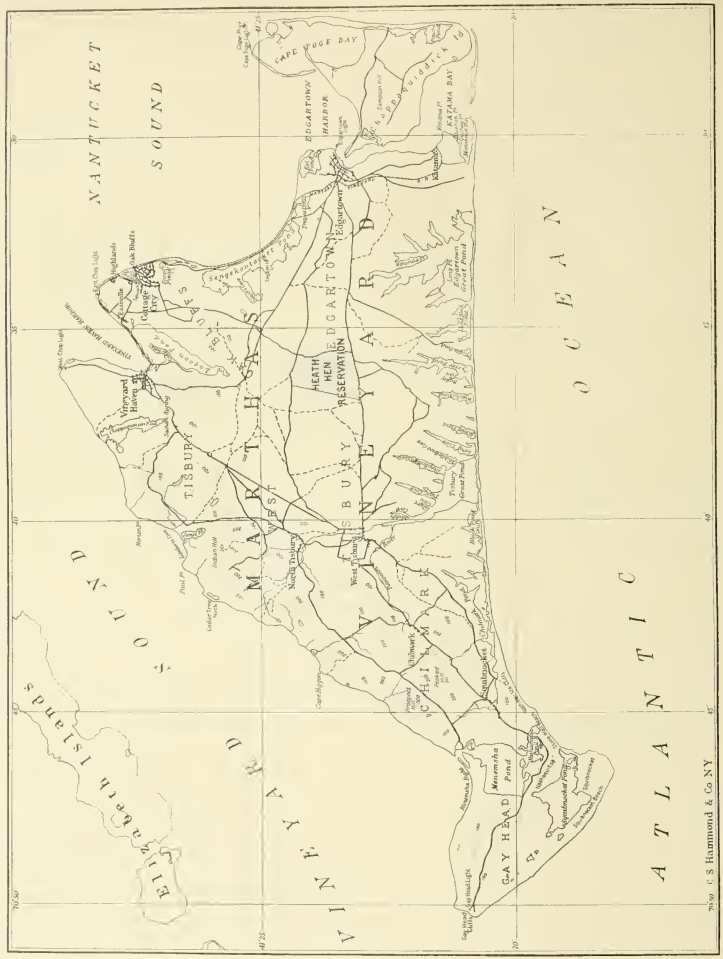
As a result of this agitation for the protection of the Heath Hen, laws were passed by the Massachusetts Legislature declaring a closed season for five years and a fine of $100 for hunting, taking or killing, or for buying, selling or otherwise disposing of or having in possession a Heath Hen or any part thereof, for the next five years.

In the report of the Commissioner on Fisheries and Game for 1906 the following statement is made: "According to our observations during May, we estimate that the number

of birds of this species [Heath Hen] now alive in the whole world does not exceed 80. We actually counted 21 birds, none of which, we were reasonably certain were counted twice."

In 1907 Dr. Field (1907, p. 249; 1908, p. 56) made the following report concerning the numbers of Heath Hen on Martha's Vineyard: "Careful daily observations, extending from October 1906 to May 1907, showed that the inhabited area has become restricted to about thirty square miles, and the probable number of individuals to less than one hundred. By actual count of the flocks very definitely located in various sections of the range, seventy-seven different individuals were accounted for. In May 1906, a destructive forest fire swept practically the entire breeding grounds, and very few birds were reared that season. The summer of 1907, however, was a favorable one. We know that at least ten broods were successfully reared, and our census this year will probably show that the number of birds has more than doubled."

The year 1907 witnessed one of the most notable steps taken in the history of the Heath Hen to preserve the species from extinction. It was the establishment of a reservation in the midst of the breeding range where the birds could be studied and protected by competent wardens. The establishment of this reservation is so important that it seems desirable to include the entire account as given in the 1907 Annual Report of the Commissioner on Fisheries and Game, pages 64 to 66 inclusive: "The value of the birds as a local asset was early appreciated by many of the best people, but to J. E. Howland is due the credit for initiating the action which promises to prevent for all time the extermination of this bird. Mr. Howland called the attention of the Massachusetts Commissioners on Fisheries and Game to the conditions, and a permanent guardian was located in the midst of the region inhabited by the birds, to study their habits and to enforce the law. Amply supported by public opinion, Representative [Ulysses S.] Mayhew introduced a bill, placing under the control and use of the Commissioners on Fisheries and Game such lands as may be donated, leased, purchased or otherwise placed under temporary or permanent control as a refuge and breeding area for the Heath Hen. Already a considerable amount of money has been pledged by public-spirited individuals and associations for the purpose, and about 1,600 acres placed under special protection. In order that the expense may be minimized, the Legislature authorized the commissioners to take, 'for and in the name of the Commonwealth, such unimproved lands upon Martha's Vineyard, not exceeding 1,000 acres, as they may deem necessary for the purpose of making fire-stops for the protection from fire of the feeding and breeding grounds of the pinnated grouse, or of otherwise securing the maintenance and increase of such pinnated grouse, or of any other species of wild birds upon said islands.' For work 'incidental to these purposes, and for an investigation and reports upon the best methods and probable cost



TEXT-FIG. 1.—Map of Martha's Vineyard, Massachusetts.

of protecting and increasing the colonies of birds on the island,' $2,000 was appropriated by the last Massachusetts Legislature.

"We have carefully investigated the problems involved in the permanent maintenance of the heath hen, and have concluded that:

"1. One or more extensive areas, as reservations or sanctuaries, should be acquired by the Commonwealth, patrolled and maintained. These sanctuaries should include the principal breeding and feeding grounds of the birds. Some of the land should be annually plowed and sown to clover, rye, corn, wheat, buckwheat, etc.

"2. Suitable and sufficient fire-stops should be made and maintained in order to minimize the danger of brush fires, which have in the past proved so disastrous to the birds, vegetation and property.

"3. All possible precautions should be taken against the introducing of infectious disease, such as, *e.g.*, Entero-hepatitis, Coccidiosis, 'white diarrhoea,' chicken cholera, etc., which may be transmitted to the grouse through the agency of domestic hens, turkeys, ducks, geese, etc.

"4. As soon as the number of birds has increased sufficiently, systematic artificial incubation, feeding and brooding should be undertaken for the purpose of rearing annually an increased number of young birds. By artificial propagation we may expect to increase the number of eggs laid, to lessen the loss resulting from the destruction of nests and eggs by skunks, mice and other enemies, and to reduce the mortality by guarding the young birds against crows, hawks, jays and other enemies.

"5. The expense involved would be practically identical with that incidental to ordinary poultry raising, except that on account of the hardiness and vigor of the grouse, the expense of housing the adult birds would be well nigh eliminated."

In addition to practical and most valuable assistance by W. Dutcher, Esq., president of the National Audubon Society, John E. Howland, Capt. B. C. Cromwell and many others, contributions for the purchase of land for a reservation and for making fire-stops on Martha's Vineyard were pledged as follows:—Middlesex Sportsman's Association and Town of Tisbury, each $200; William Brewster, F. S. Pearson, G. B. Clark, John E. Thayer, H. H. Fay, S. M. Weld, F. E. Peabody, L. D. Baker, A. F. Whitin, Judge F. C. Lowell, Dr. John C. Phillips, R. C. Robbins, Gardner M. Lane, Dr. B. H. Kidder, Hon. Herbert Parker, Dr. Gorham Bacon, National Audubon Society, W. P. Wharton, each $100; Town of West Tisbury, Anawan Club, R. L. Agassiz, each $50; Hon. A. P. Gardner, Edward L. Parker, each $25 and smaller gifts by Clinton G. Abbott, Mrs. Carroll Dunham and Harriet E. Freeman making a total of $2,420.00.

As a result of the interest shown by various institutions and individuals the Commonwealth of Massachusetts in 1908 purchased six hundred acres of land situated near the

TEXT-FIG. 2.—The Heath Hen Reservation, and the State forest. The cross-hatched portion indicates the area made into additional sanctuary for the Heath Hen. Courtesy of the Division of Forestry of Massachusetts.

center of Martha's Vineyard in the midst of the breeding range of the Heath Hen. This land included a small barn and a modest dwelling house which was later improved and used as a home for the superintendent of the reservation. The Commonwealth also secured the lease of an additional tract of one thousand acres at a rental of $400 per year.

In 1908, according to Dr. Field (1913, p. 352) there were between forty-five and sixty Heath Hen. By the following year there was an estimated number of two hundred and in 1910 the birds increased to about three hundred. In the winter of 1910 and 1911 there was a notable decrease in the numbers of birds. Numerous skeletons were found, some plainly indicating the work of cats, hawks and other agencies, so that by June, 1911, there were probably not more than one hundred and fifty birds remaining. The birds rallied the following year (1912), increasing to an estimated number of three hundred.

On March 15, 1913, William Day was given charge of the reservation. Extensive and systematic improvements were carried on by the State with a view to making the area more attractive for the Heath Hen. The first step in this development was the installation of a system of fire-stops made by clearing long lanes about seventy feet wide from which all trees and bushes were removed and the ground turned over to destroy all the remaining inflammable material. In his annual report to the Commissioners Mr. Day stated that he counted fifty-one Heath Hen on August 24 which were feeding on blueberries and on November 6 he saw a flock of eighty birds on the reservation. From these and other observations Mr. Day concluded that a conservative estimate indicated an increase of 40 per cent over the preceding year which, if correct, would mean that there were over four hundred Heath Hen on the island in 1913. This group of birds was guarded with care; crops were planted to afford sufficient winter food, a constant patrol was made of the reservation against poachers, and an endless warfare was waged on the vermin, especially rats, hawks and stray cats. During the year fifteen Marsh Hawks, three Sharp-shinned Hawks, five Red-tailed Hawks, twenty-three cats and one hundred and eighteen rats were killed. Some of the semi-wild cats were of enormous size and wherever present proved most destructive to the Heath Hen.

As a direct result of this efficient protection afforded by the reservation the birds increased very rapidly and in 1915–16, Mr. Day stated that the birds were in all parts of the island with the exception of Gay Head, the extreme western end of Martha's Vineyard. It was possible, he states, to flush a flock of three hundred birds any fine afternoon from the corn and clover plot. In April, 1916, E. H. Forbush (1917a, p. 1) visited the reservation and noted fully eight hundred birds and Mr. Day estimated there were fully two thousand Heath Hen on the island. This was a great triumph for those who had encouraged and fostered the reservation.

In spite of the unusual precautions taken to prevent the spread of fire on the

reservation, a fire broke out during a gale on May 12, 1916, which swept the greater part of the interior of the island destroying the cover on more than twenty square miles in the towns of Vineyard Haven, Oak Bluffs, West Tisbury and Edgartown, right in the heart of the breeding area of the Heath Hen. This fire undid the splendid work which the Massachusetts Commission accomplished under the leadership of Dr. Field, since the establishment of the reservation.

There is more or less conflict of opinion as to the number of birds killed by the fire. Many observers who visited the scene of destruction immediately after the fire reported seeing no dead birds, but we are certain that the fire proved most destructive either directly or indirectly to the Heath Hen colony. Later investigations revealed there were very few young birds, indicating either that many nests and eggs were destroyed or else that the birds would not breed on land which was recently burned over. Mr. William C. Adams reported finding one nest containing seven eggs which was destroyed by the fire and Mr. Day stated that large numbers of eggs were destroyed and afterward, there being no cover, the birds dropped their eggs in places where they were destroyed by Crows. One of the indirect effects of the fire was the destruction of the cover and the native food supply. A hard winter followed the fire and in the midst of this came an unprecedented flight of Goshawks. The Goshawk is well known as one of the worst enemies of our game birds and the Heath Hen being without the usual cover for protection were slaughtered by this host of unwelcome visitors from the north. A Goshawk killed by Mr. Day had its stomach gorged with Heath Hen. Mr. Day also reported finding within three weeks after the fire ten skeletons of the Heath Hen which to all appearances had been killed by Hawks. The net result of the fire was an amazing decrease in the number of birds. Mr. Forbush made a visit to the island in April, 1917, and on territory where in 1916 the males could be heard booming in all directions, hardly a bird could be located. After a careful survey lasting three days he estimated there were less than fifty pairs left.

On April 21, 1916, a conference was held at the office of the Commissioners of Fisheries and Game which was attended by T. Gilbert Pearson, Secretary of the National Association of Audubon Societies, E. H. Forbush, State Ornithologist, Winthrop Packard, Secretary of the Massachusetts Audubon Society, Dr. George W. Field and others. At this conference it was voted to make the experiment of planting colonies of Heath Hen upon the mainland. Unfortunately this transplantation was not undertaken until after the destructive fire and the taking of the birds at that critical time served still further to reduce the depleted numbers. Long Island, one of the former strongholds of the Heath Hen, was selected as one of the first places to which a transplantation was to be attempted. The New York Conservation Commission expressed a keen desire to cooperate and as a result of its request, eighteen Heath Hen, comprising eleven males and

seven females, were shipped from Martha's Vineyard to Long Island on December 23, 1916. Dr. John C. Phillips of Wenham, Massachusetts, who had had much experience in breeding game birds, was given eight Heath Hen (five males and three females) for an experiment in breeding the birds in captivity in closer quarters than were planned by the New York Conservation Commission. In spite of the fact that those who received the birds were well qualified to conduct such experiments, and though they made elaborate preparations to insure the success of the trials, the results were uniformly unsatisfactory. On Long Island the birds were placed in a three-acre enclosure with natural conditions much like those on the reservation from which they were taken. The birds were wing-clipped and each was placed in a small breeding pen within the enclosure for two weeks before they were allowed the liberty of the larger area. Seven of the Heath Hen, in spite of great diligence on the part of the keeper, were lost through Hawks and Owls. On March 1 the males showed signs of mating but kept together and did not pair off with the females. The latter showed no signs of nesting and did not lay any eggs. On July 1 the birds appeared droopy and soon began to die until the remaining eleven were dead. According to Harry T. Rogers, superintendent of the game farm, the birds died of "tuberculosis of the bowels" although Hon. Marshall McLean of the New York Commission reported that an investigation of the carcasses failed to disclose any particular disease. Whatever the cause, the experiment was a failure.

Dr. Phillips mated the birds which he received and placed them in covered breeding pens about 20 by 20 feet. One of the females was accidently killed. The males of the mated pairs did not boom whereas Prairie Chickens he had before, boomed continuously for several weeks. One of the spare males was killed in a fight and upon dissection Dr. Phillips found the testes extremely small in spite of the fact that the time was the height of the breeding season. The same condition was found in two birds examined later. The experience of Dr. Phillips seems to indicate that the sterility of the males was an important factor in the failure of his experiments. (No report was made concerning the sexual condition of the males shipped to New York.) This sterility factor may be of importance in connection with the remaining birds on Martha's Vineyard. Dr. Phillips sent several birds to Joshua Crane on No Man's Land, Massachusetts, in July, 1917, but nothing was ever heard from them.

In connection with these experiments to transplant Heath Hen it is interesting to note that repeated attempts have been made to introduce Prairie Chickens in various States along the Atlantic seaboard as well as in many foreign countries. Prairie Chickens were introduced on Cape Cod, Massachusetts (Forest and Stream, 1877, vol. 9, p. 11) when it was predicted that in time they would spread and populate the whole Commonwealth, but I have not been able to find reports of their subsequent abundance. As early as

1852 Prairie Chickens were liberated at Keyport, New Jersey, on the farm of Charles Fletcher (Porter's Spirit of the Times, 1852, vol. 22, p. 126). Dr. J. F. Purnell of Berlin, Worcester County, Maryland, liberated two pairs of Western Pinnated Grouse (Prairie Chickens) in the vicinity of Snow Hill, Maryland. The first season after liberation they raised twelve or thirteen young and in 1874 it was estimated that there were about two thousand Prairie Chickens in that region ("Homo," 1874, p. 149). In 1872, W. E. Newton of Smithtown introduced thirty pairs of Prairie Chickens from Iowa to Long Island, New York. In 1874 the birds were breeding and doing well and were not to be disturbed until 1887 (Editorial, Forest and Stream, vol. 2, p. 75). In 1880, one hundred pairs were liberated in Burlington County, New Jersey (Forest and Stream, vol. 25, p. 103). Early in the eighties a lot of Pinnated Grouse was liberated in Maine where they were protected by a three-year closed season. The birds flourished and increased and it is said that in the autumn of 1888 (?) one gentleman killed thirty or forty of them (Forest and Stream, 1888, vol. 31, p. 451). In 1891, three hundred were liberated in Plymouth, Barnstable and Bristol Counties, Massachusetts (Forest and Stream, 1891, vol. 36, p. 188) and later it was reported that these birds had increased to an estimated number of about seven hundred to one thousand (Forest and Stream, 1891, vol. 37, p. 207). I am inclined to believe that some of the estimates given above are not real but are products of the imagination.

Many similar introductions of the Western Prairie Chickens were made in the eastern States and although a few of these introductions may have given promise of success at first, the birds dwindled in numbers and finally disappeared entirely. Thus far every attempted transplantation of Pinnated Grouse has resulted in failure. This Grouse, though a seemingly hardy bird, is very sensitive to radical changes in its environment. It is not adaptable to new conditions which involve different food and cover, and where it is exposed to new enemies and diseases. It is problematical, even if the Heath Hen is restored to large numbers on Martha's Vineyard, whether it ever can be successfully transplanted to the mainland and there be maintained permanently in large numbers. It is remarkable, however, that in the checkered history of the Heath Hen on Martha's Vineyard, where its extinction has been expected and predicted so many times, it still survives.

The Heath Hen seemed to rally after the great catastrophe of 1916 and they increased rapidly for a few years from the low level reached in 1917. In 1917 William Day, who held the double position of superintendent of the reservation and district deputy, resigned to undertake other work. James Peck was appointed temporarily until April 8, 1918, when Allan Keniston succeeded Mr. Day as superintendent of the reservation with the understanding that his entire time be devoted to the protection of the Heath Hen.

When Mr. Forbush went to Martha's Vineyard in April, 1918, he saw but twenty-one birds and estimated that there were one hundred and fifty of them on the island. He emphasized the necessity of having an efficient warden on the reservation to prevent poaching and law-breaking.

In April, 1918, Norman McClintock took a series of moving pictures illustrating the details of the courtship behavior of the Heath Hen. These were the first moving pictures made of the birds but since that time several expert nature photographers, including Herbert K. Job, have been to the island to record the activities of these interesting birds in moving pictures.

Hon. William C. Adams, then of the Commission of Fisheries and Game since 1916, following his plan of securing advice from the most eminent authorities on birds in the matter of restoring the Heath Hen, made a request of the U. S. Department of Agriculture to have Dr. A. K. Fisher of the Biological Survey make an inspection of the reservation. Dr. Fisher in his report of May 16, 1918, emphasized the importance of fire and vermin control and made certain suggestions in order to accomplish the best results. Mr. Adams immediately put into the plan of the work all suggestions made by Dr. Fisher, not already in operation.

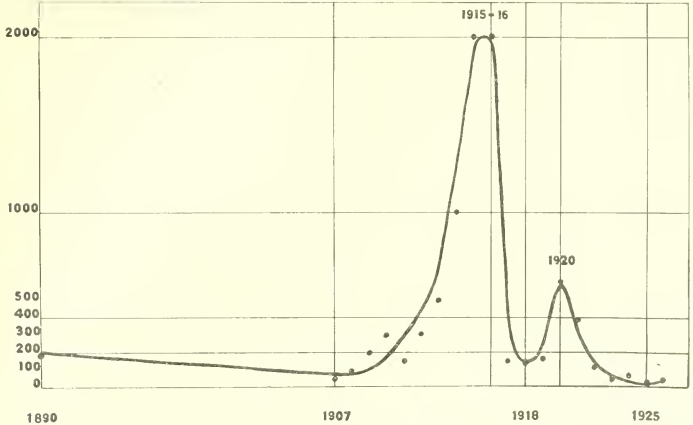
On January 7, 1919, Allan Keniston reported seeing one hundred birds on the reservation and during the summer he saw several large broods of young. Very favorable weather during the breeding season resulted in a substantial increase in the numbers of birds. The superintendent gave special attention to the control of vermin and during the year killed nineteen cats, thirty-five Hawks and two hundred and fifty-eight rats. At this time there was a great increase in the number of rats, not only on the reservation but in all sections of the island. Many of the farmers reported large losses in their crops from the so-called plague of rats but as in a more recent instance the losses were probably exaggerated.

In the autumn of 1919 the birds were located in widely separated portions of the island, a condition probably brought about or at least aided by the fire of 1916 when the birds were driven to the edge of the plain, notably to the northeast, east and south. As there was no cover on the plains the birds were obliged to nest on the outskirts of the fire area and at that time were found around Katama, Edgartown Great Pond and Sengegantacket Pond. The land around the ponds was not burned over, food was abundant and the young remained in places where they were hatched. This wide distribution of the birds is favorable rather than unfavorable to the Heath Hen because it tends to lessen the effects of interbreeding. Fires or disease are not so likely to exterminate all of the birds on the island if they are in widely scattered companies.

The birds continued to regain their lost ground and by the spring of 1920 Mr. Keniston

reported that it was not unusual to see forty-five to fifty birds feeding at one time on the hill near the reservation house. At the usual spring census made by Mr. Forbush a total of three hundred and fourteen birds was counted and Mr. Keniston ventured the estimate of six hundred birds for the entire island. This apparent recovery was only temporary for the numbers were so greatly reduced the following year that the annual census revealed only one hundred and seventeen individuals. Mr. Keniston attributed this decrease largely to unfavorable weather during the nesting season of the previous year. He states that frost occurred three times in May and once in June. The frost was severe enough to crack eggs which were exposed and undoubtedly many of the Heath Hen eggs not yet incubated were thus destroyed. This supposition was borne out by the few small broods seen during the summer of 1919. In spite of great precautions taken by the State to provide protection and food for the birds, the Heath Hen steadily decreased in numbers. By 1922 they had decreased to such an alarming extent that their future seemed uncertain. William C. Adams, director of the Division of Fisheries and Game, realized the gravity of the situation and in February, 1923, he sent a questionnaire to leading ornithologists, sportsmen and others interested in the Heath Hen explaining the status of the birds. The primary object of this questionnaire was to test public opinion as to the advisability of the State continuing the reservation on Martha's Vineyard at an expense of over $3,000.00 per annum (total expenditures from 1907 to 1926 inclusive are $60,857.41 but in some years it exceeded $5,000.00) with no positive results to show for this expenditure of money and effort. Had this step not been taken the Heath Hen might have been snuffed out of existence with very few of us being the wiser until after it was too late. The response to this questionnaire was greatly in favor of exerting all reasonable efforts in saving the Heath Hen. The members of the Nuttall Ornithological Club of Cambridge, Massachusetts, and the Brookline Bird Club, of Brookline, made recommendations to the director that an investigation be made of the conditions which govern the existence of the birds on the island and that a life-history study be undertaken in order to gather all the information possible concerning them before it was too late. Mr. Adams did all he could to secure funds for this purpose, even appealing to the Governor's Council, but was refused all aid. Dr. John C. Phillips then came forward and took the initiative in causing this study to be made and he, with the assistance of Dr. Thomas Barbour, Colonel J. E. Thayer, C. A. Mackey, W. P. Wharton, C. F. Batchelder, Augustus Hemenway, Dr. W. M. Tyler and F. A. Foster, provided the means for its execution. This study was begun by the writer on April 9, 1923, and was continued until the latter part of July of that year. A visit was made in November, 1923, March and April, 1924, May, 1925, and others in 1926, 1927 and 1928, under the auspices of the Federation of New England Bird Clubs, Inc.

When I went to Martha's Vineyard in April, 1923, a thorough census was made of the entire island at which time we accounted for only twenty-eight birds located in small isolated groups within a radius of eight miles of the reservation. Such a census is made possible for the reason that in the spring the birds regularly make their appearance on the open fields to feed and to go through their weird courtship antics. These performances usually occur during the early morning hours following the first light of dawn and again late in the afternoon just before and after sunset. Not all of the birds leave their protected haunts at such times but the numbers seen on the so-called "scratching" or



TEXT-FIG. 3.—Graph indicating the rise and fall of the numbers of the Heath Hen, constructed from estimates of various observers in the years between 1890 and 1926. (See text).

Since this graph was constructed the estimates of the numbers of birds made in 1927 and 1928 and the daily reports up to May, 1928, indicate that the number of birds is slowly but steadily declining.

"tooting fields" are an index to the numbers present and form a basis for the comparative estimates of the Heath Hen population. These estimates are modified by the daily reports of the wardens and by records of other reliable observers taken throughout the year. A census based on such determinations is not as accurate as is desired but it is the only means we have of making counts which can be used in comparing the status of the birds from year to year. It is probable that the estimates made in the past have been affected by the personal factor and some of them may have been larger than the facts warranted. These estimates, however, are near enough to indicate the chief peaks of abundance and depletions in numbers as is shown by the accompanying graph

(Text-fig. 3). There is no doubt that the birds were abundant in the early spring of 1916 and with the exception of a slight rise in 1920 have come down to the present low ebb indicated by the graph. This dip is too low to make us feel optimistic concerning the future recovery of the Heath Hen.

A fact noted by former observers but emphasized in the present study is the existence of an excess of males. All efforts to find females in the spring of 1923 failed, but during the summer two females with small broods of young were noted in places remote from the reservation. Recommendations were made to isolate a few of the males (not more than five) from the group present on the western field near the superintendent's house. Fish-net traps with a figure-4 device were used in capturing the five birds which were placed in special pens built among the scrub oaks remote from the poultry. Unfortunately all of the birds died in captivity but each body was preserved for anatomical study.

It was gratifying to know that in April, 1924, there were fifty-four Heath Hen, whereas the census taken under similar circumstances in 1923 yielded only twenty-eight birds. These birds were distributed in several distinct groups and while the increase was general, the most marked increase was on the reservation where the numbers went from twelve to twenty birds. That these additions did not come largely from other parts of the island is evidenced by the fact that all of the flocks maintained or slightly increased their numbers. One of the most promising features of the census was the regular appearance of three females on the "scratching field."

The elimination of the five males in 1923 may or may not have had its influence on this increase, but it is probable, as discussed in another section of this paper, that the excess of males is a factor of importance in the biology of the Heath Hen. In the spring of 1924 four more males from the reservation were taken to assist in the adjustment of the sex ratio. Although there were seventeen males to three females it was deemed best not to reduce the number of males by more than four. During the summer of 1924, following the encouraging conditions found in the spring, four broods were reported. One of these seen by Allan Keniston on June 23 comprised a large family of ten chicks. During the winter flocks of Heath Hen were seen and all news from the reservation seemed to indicate that the birds were holding their ground but when I went to the reservation the following spring, on May 12, our high hopes and expectations were not sustained. Apparently many of the birds had died or were killed by some agency the nature of which we have never been able to ascertain. Instead of an increase of the numbers over the preceding year, only three birds could be located on the open fields. On James Green's farm only one male appeared and on the reservation where there was a large flock including three females in 1924, there were only two male birds. None was seen during many miles of driving and walking about the reservation where they were met with in

previous years. When Mr. Forbush visited the island in April he saw but two birds and heard none booming. All the evidence pointed to the conclusion that the birds were at their lowest ebb and an estimate was ventured based on numbers seen during the winter that there were not more than twenty-five Heath Hen in existence on the whole island.

Action of Federation of New England Bird Clubs, Inc.—The State was doing all that it could to save the birds from extinction, yet it was failing to accomplish its purpose. The outlook was discouraging. William C. Adams discussed the status of the Heath Hen at length with officers of the Federation of New England Bird Clubs and it was decided to call a Heath Hen conference at the State House on June 4, 1925, at which certain definite recommendations would be offered. A report on the status of the Heath Hen was read and after long and deliberate discussions the following recommendations were passed:—

1. That the work of providing food for the Heath Hen be continued and the birds baited and kept on the reservation as much as possible for closer care and protection.

2. That one additional warden with State authority be sent to the reservation and stationed there from October 1 to March 1 with instructions to make a complete patrol of the entire reservation and vicinity each day; and that this patrol be rigidly enforced; the salary of this warden and expenses to be paid from funds raised for that purpose by the Federation.

3. That James Green of West Tisbury, Martha's Vineyard, be made a warden.

4. That an emergency fund of $2,000.00 be raised by the Federation of New England Bird Clubs to aid in the work of protection and that the money raised be disbursed by the Federation.

This action of the Federation is one of the most important steps taken to save the Heath Hen from extinction since the establishment of the reservation in 1907. As soon as the Federation took the initiative it was assisted by the Massachusetts Audubon Society, the Massachusetts Fish and Game Protective Association, the Massachusetts Forestry Association and general subscribers. These organizations coöperated with the Division of Fisheries and Game to do all humanly possible to save this bird from extinction.

The committee secured the services of J. J. Slauterback, chief of the Bureau of Vermin Control of Pennsylvania, to begin the work of vermin control on Martha's Vineyard and to instruct the wardens in his special methods. Mr. Edward F. McLeod was employed by the Federation on June 10, 1925, as a special warden. In order to clothe him with proper authority he was made a deputy warden by the Division of Fisheries and Game of Massachusetts and a federal game warden by the U. S. Bureau of Biological Survey, Washington, D. C.

On July 7, 1925, Mr. Slauterback made an informal report concerning conditions on Martha's Vineyard, emphasizing the importance of controlling Heath Hen enemies, especially cats and predaceous birds. He also mentioned having indirect evidence that the Heath Hen were being killed by the natives of the island. This latter statement again emphasizes the great importance of creating favorable public opinion on Martha's Vineyard. Unless the islanders are in complete sympathy with our problem the work will be seriously handicapped. Since Martha's Vineyard has been given such wide publicity through the Heath Hen, recently, certain influential people of the island who formerly were indifferent are now taking an active interest in the birds. Outwardly, at least, there seems to be less opposition and we hope that a growing local sentiment on the part of the sportsmen and general public will make poaching impossible.

In the period from July 1 to November 1, 1925, Mr. McLeod, the Federation warden, disposed of forty-two house cats, twenty Crows, ten rats, seven Hawks and two Owls. Mr. McLeod's activity stimulated the State to greater efforts and Mr. Keniston extended his trap lines to regions well beyond the limits of the reservation. The two wardens patrolled every locality where Heath Hen were known to exist and kept in close touch with the birds. In the annual census made in April, 1926, under the auspices of the Federation we observed a total of fifteen birds and an estimate of thirty-five was made for the entire island. While there was no evidence of a marked increase, the birds seemed to have maintained their numbers and the Federation decided to continue the services of Mr. McLeod for another year. During 1926 the activities of the State and Federation were greatly increased, especially in the control of predaceous birds and mammals. From December 1, 1925, to November 30, 1926, Mr. Keniston, superintendent of the reservation, and Mr. McLeod succeeded in disposing of one hundred and twenty cats, fifty-one Crows, thirty-seven Hawks, one hundred and eleven rats and three Owls, a total of three hundred and twenty-two potential enemies of the Heath Hen. Food was provided, the birds were carefully guarded and everything possible was done to assist the birds. In the census made in March, 1927, we could account for only thirteen birds and there were probably less than thirty birds on the entire island. It was apparent that our hopes of greatly increasing the number of Heath Hen were not realized. The numbers reported from year to year are subject to considerable error because of the difficulties involved in making the census, but I am inclined to believe that during the past few years the birds have scarcely held their own. The problem of saving the Heath Hen is not the simple one of providing protection against Hawks and cats and supplying food when needed but it is much more complex. There are other factors such as the inadaptability of the species, excessive interbreeding, excess male ratio and disease which are most important in the decline of the Heath Hen.

The State Division of Fisheries and Game has expressed its determination to continue the Heath Hen reservation as long as there is a living Heath Hen. This year positive steps have been taken to fight disease and additional garden plots have been planted on the forestry reservation to provide special food for the birds. A large part of the State forest of nearly five thousand acres has been closed to hunting to reduce to a minimum the disturbances caused by hunters during the open rabbit season (see text-fig. 2, p. 510). Adjacent land owners have also agreed to close their property to hunters so that practically all the area occupied by the birds at the present time will be free from disturbance during the hunting season. The fire-stops are being continued and greatly extended by the Division of Forestry which will decrease the chance of extensive forest fires.

The Division of Fisheries and Game has added an additional warden on Martha's Vineyard who will serve as an assistant to the superintendent of the reservation in protecting the birds. In view of the fact that the State is doing all that is practicable, the Federation discontinued its own warden, on May 1, 1927. Furthermore, a committee consisting of Martha's Vineyard sportsmen and citizens interested in the Heath Hen has been organized to assist in the work of conservation (Clark, 1927, p. 10). Sportsmen, ornithologists and bird lovers the world over will await with keen interest the final outcome of the struggle for existence the Heath Hen is waging.

The Heath Hen from the Sportsman's Point of View.

The Heath Hen even when in its prime was never given a high place among game birds by the sportsmen. It was easily shot because of its direct and laborious flight, and the habit of massing in flocks in the open fields made it too easy a victim for the pot hunter and market gunner.

The western Prairie Hens whose habits are, presumably, similar to those of the Heath Hen, usually lie very close, and often they may run in front of the dogs, clucking nervously, with their heads just above the grass. When the birds flush usually one or two of them spring into the air at a time giving the gunner, if he so desires, an opportunity to kill a large part of the flock.

The ease with which the Heath Hen was killed readily accounts for the rapidity of its early disappearance from the mainland, whereas the clever Ruffed Grouse of the woodlands still holds its own and is ever ready to challenge the wits of the most skilled sportsman.

The attitude of the sportsman of the past to the Pinnated Grouse is well illustrated by the following excerpt from an article written by Elisha J. Lewis in the American Sportsman of 1855. "So numerous were they a short time since in the barrens of Kentucky, and so contemptible were they as game birds, that few huntsmen would deign to waste powder

and shot on them. In fact, they were held in pretty much the same estimation, or, rather abhorrence, that the crows are now in Pennsylvania or other of the Middle and Southern Atlantic States, as they perpetrated quite as much mischief upon the tender buds and fruits of the orchards, as well as the grain of the fields, and were often so destructive to the crops, that it was absolutely necessary for the farmers to employ their young negroes to drive them away by shooting off guns and springing loud rattles all around the plantations from morning till night. As for eating them, such a thing was hardly dreamed of, the negroes themselves preferring the coarsest food to this now much admired bird: while the young sportsman exercised his skill in rifle shooting upon them in anticipation of more exciting sport among the other prized denisons of the plains and forests."

It is apparent that the Heath Hen was not considered an ideal bird from the point of view of the sportsman and our efforts to save the Heath Hen today cannot be made on the plea that it is of great economic importance as a game bird. It is interesting to note, however, that it is the sportsmen who have taken the initiative and who are providing a large part of the funds to assist the State in the preservation of this unique species.

Enemies and other Factors involved in the Decline of the Heath Hen.

Man.

Man directly or indirectly is in part responsible for the disappearance of the Heath Hen from most of its former range. Comparatively soon after the coming of the white man it was driven from one locality to the next until it was forced to entrench on the scrub-oak plains of Martha's Vineyard Island. It is a striking example of a bird which has not been able to adapt itself to the changing conditions brought about by civilization. It has never yielded to conditions of confinement and repeated attempts to transplant it have failed. The belated efforts of man to control factors which seem to concern the future existence of the Heath Hen have thus far not been successful in greatly increasing the number of birds. Some of the more important problems which have a bearing on the life and conservation of the Heath Hen are given in the following pages.

Predaceous Animals.

Cats.—When the Heath Hen existed under primitive conditions there was a constant struggle against natural enemies such as predaceous birds and mammals. Since civilized man has become a part of the environment certain enemies of the Heath Hen have decreased but others, such as the cat and the rat, have become more important in the life of these birds.

Audubon wrote in 1842: "We frequently meet with the remains of such [Heath Hen] as has been destroyed by the domestic cat which prowls in the woods in a wild state."

What was true in Audubon's day is true today in a greater degree. Cats are ranked high among the enemies of the Heath Hen, and in view of this fact the State Department of Conservation and the Federation of New England Bird Clubs, Inc., through their wardens have been waging a relentless warfare on them.

The winter population of Martha's Vineyard is five thousand whereas the summer residents are said to exceed fifty thousand persons. Many of the summer people bring cats to the island for the purpose of catching rats and mice about their summer homes. In the fall when the cottages are closed the cats are thoughtlessly abandoned. Furthermore the ridiculous superstition concerning the killing of cats is so firmly fixed in the minds of some of the native people, that in order to avoid "bad luck" the cats are not killed but are carried to the scrub-oak plains to be set free.

This abominable practice tends ever to increase one of the worst enemies of the Heath Hen. It is gratifying to note, however, that within the last year since great publicity has been given this matter, fewer cats have been abandoned. During the year from December 1, 1925, to November 30, 1926, Mr. Keniston and Mr. McLeod killed one hundred and twenty cats, giving evidence that there are still large numbers of them on the island. This record also speaks well for the effectiveness of the work of these two wardens. In fact, the cat population has been so greatly reduced that complaints have been coming in this year (1926) of an increase in the number of rats, again affording us with an example of what may happen when man attempts to regulate Nature.

However, according to James Silver, of the United States Biological Survey, cats have little or no bearing on the rat population of Martha's Vineyard. The cats ranging the plains find few rats and subsist largely on the white-footed and meadow mice which are very abundant through the scrub-oak area where practically all of the cats are trapped.

The average weight of twenty-five adult cats secured on the island was nine pounds but some of the largest specimens weighed more than twelve pounds and one unusually large one trapped August 4, 1925, weighed eighteen pounds. The majority of the cats killed are in good condition indicating that they are able to secure an abundance of food. The contents of the stomachs examined by Mr. George M. Gray of the Marine Biological Laboratory, Woods Hole, Massachusetts, and others sent to my laboratory have revealed but little. The stomachs of most of the cats were empty or contained bait used in the traps. In a few there were remains of rodents, chiefly mice, traces of insects and miscellaneous material. Though these examinations give us negative evidence, the nature of the semi-wild cat is too well known to take a chance in allowing it to roam in uncontrolled numbers over the plains inhabited by the Heath Hen. I cannot conceive of a hungry cat passing by a brood of young Heath Hen without an attempt to kill some of them.

Rats.—Until three years ago it was the practice of the State to leave quantities of corn and other grains unharvested in the fields for the Heath Hen. The birds, when they were more abundant than they are today, came in large numbers to feed on the grain but unfortunately it also attracted many rats and Crows which were thus aided in living through the winter. As a result the rats thrived and multiplied in large numbers. In 1923 there was a patch of corn planted near the eastern meadow for the sole purpose of providing food for the birds. As soon as the corn was mature it was shocked but a small part of it was left standing. When I visited the field in November almost every shock was undermined by numerous tunnels and excavations made by the rats, and on every hand there was evidence of their destructiveness, even the squashes and pumpkins in the field were gnawed and opened for the seeds they contained. Crows also were frequent visitors to the field but not a single Heath Hen was seen to go near the place. In view of these facts it was recommended that the practice of leaving corn and other grains in the fields be discontinued and in their place proper food be purchased to be distributed in small amounts as needed by the Heath Hen. As a result of this change in methods the rats deserted the reservation many of them going to the nearest farmhouses from which came bitter complaints of a plague of rats. This plague was greatly exaggerated but in a few cases the rat menace was real. Certainly the rat population of the reservation today is negligible as compared to the conditions which existed two or three years ago. This condition has resulted not only from doing away with the practice of leaving crops in the field but from the efforts of the superintendent to exterminate those rats which remained.

Rats have been condemned by certain persons interested in the Heath Hen as the principal cause in its decrease but it is very doubtful if the rats play an important rôle in the struggle of this bird for existence. The chief way in which rats might affect them would be by destroying their eggs or preying upon the young, but the environment selected by the nesting birds is totally unsuited for house rats. It is rare to see them in such places except for chance migrations. Nevertheless, it has been recommended to keep the rats under control and the wardens have made it one of their duties to exterminate rats whenever possible.

Aside from the cats and rats there are no predaceous mammals that seriously menace the Heath Hen today. In the past foxes were introduced on the island by sportsmen but these proved such an annoyance to poultry raisers that they have long since been exterminated. The skunk is mentioned especially in the writings of the older ornithologists as an enemy of the Heath Hen but I have been able to find no recent evidence to bear out this supposition.

Hawks.—There are few places that I have visited for ornithological work where there

were more Hawks than on the plains of Martha's Vineyard. These Hawks are attracted by the countless numbers of mice and shrews which live among the scrub oaks. Unfortunately many of the Hawks which ordinarily have a good reputation elsewhere, on Martha's Vineyard are frequently tempted to prey upon birds, including the Heath Hen. According to Mr. Keniston, who has kept a record of the Hawks he has killed and seen, the Marsh Hawk is by far the most abundant species and this coincides with the impressions I have gained during my visits to the island. In the 1911 Annual Report of the Massachusetts Commissioners on Fisheries and Game (p. 11) there is a detailed account of the examination of the stomach contents of twenty-six Marsh Hawks made by Dr. A. K. Fisher of the United States Biological Survey. These Hawks, collected on Martha's Vineyard from July 2 to August 9, 1910, had with one exception feathers and parts of birds in their stomachs. One Hawk collected on July 4, 1910, contained the remains of a young Heath Hen.

In his report for 1915, William Day reports a case of a Marsh Hawk killing a Heath Hen, and John Howland reports a similar case. Mr. Keniston succeeded in killing a Marsh Hawk in the act of feeding on a freshly killed Heath Hen. On several occasions while making observations from a blind I have seen Marsh Hawks hovering over places where the Heath Hen were feeding. At such times the birds would crouch in the grass, their colors harmonizing so well with their surroundings that the Hawks, apparently, did not see them. On May 19, 1924, Mr. Keniston caught a male Heath Hen in a trap but before he removed the bird it was attacked and badly mutilated by a Marsh Hawk. In this case the movements made by the Heath Hen in its efforts to escape the trap readily attracted the Hawk.

The Sharp-shinned and Cooper's Hawks are more destructive to bird life than the former species when considered from the standpoint of the individual, but they are not abundant on Martha's Vineyard Island.

More Red-tailed Hawks are reported as killed, in the records of the reservation, than any other species but Mr. Keniston informs me that this is due in part to the fact that these Hawks are more easily approached and killed than some others. A review of Mr. McLeod's records also shows that the commonest species killed by him during the past two years is the Red-tailed Hawk. This species is a permanent resident and nests on the island.

The Goshawks, notorious for their killing of game birds, have played their part in the history of the Heath Hen. The most notable instance of their depredations was in the winter of 1916–17 following the destructive fire which swept over the island. During the recent flight, 1926–27, there has been but little evidence of their presence on the island and only three have been killed up to the time of writing, March, 1927. There is but one record of a Gerfalcon since the reservation was established.

In the past Hawks such as the Red-shouldered, Rough-legged, Pigeon Hawk and others have been killed whenever an opportunity was provided. It is a question whether a wholesale killing of certain Hawks and Owls whose chief food is rodents does not upset the balance of nature so as to act as a boomerang to the Heath Hen.

Owls.—Several species of Owls have been reported on the reservation but as a group, Owls have played but a minor part in the biology of the Heath Hen. On several occasions while in the blind before daylight, I have seen what appeared to be Short-eared Owls flying back and forth over the reservation meadow. On May 15, 1923, a Short-eared Owl flew within a few yards of my blind at a time when there was a number of Heath Hen on the field. The Heath Hen did not seem to be disturbed in the least by the Owl's presence and it is probable that the Owl was in search of meadow mice, rather than birds. Short-eared and Long-eared Owls and Screech Owls have been captured alive by Mr. Allan Keniston for banding purposes.

Several years ago, Mr. Keniston discovered a Snowy Owl in the act of eating a Heath Hen. During the great flight of Snowy Owls to New England in the winter of 1926–27 they have appeared on Martha's Vineyard and many of them have been captured or killed. Twenty of them killed on the island were mounted by a local taxidermist. The Snowy Owl subsists chiefly on rodents, such as rats and mice, but under stress of circumstances may feed on birds.

Crows.—Crows are abundant on Martha's Vineyard where they are ever ready to feast on the food intended for the Heath Hen. The Crows do no direct harm to the adult birds and it is not an unusual sight to see the two species feeding peaceably together on the same field. After the fire of 1916 Crows were reported by William Day to have eaten many Heath Hen eggs which were deposited in exposed places on the burnt area. Mr. Keniston has also cited an instance where Crows were destroying eggs, presumably those of the Heath Hen, which the Crows had carried to a plowed field. For these reasons Crows as well as rats have been discouraged from inhabiting the range of the Heath Hen.

Diseases and Internal Parasites.

Disease has in all probability been the most potent factor involved in the decline of the Heath Hen and has seriously handicapped our recent efforts to restore their numbers. Unfortunately the number of birds is so low that material cannot be obtained for an adequate study of this aspect of the problem.

Dispharynx.—A specimen of Ruffed Grouse caught in a trap by Mr. McLeod on May 18, 1926, and sent to my laboratory for examination, was badly infected with *Dispharynx*, a nematode parasite, which first becomes established in the glandular walls of the proventriculus and in advanced cases spreads to the gizzard. This parasite has proved very

destructive to the Ruffed Grouse in southern New England and New York State (Gross, 1925, p. 56; 1925a, p. 424; 1926, p. 6). The proventriculus of a Heath Hen examined by Dr. E. E. Tyzzer on April 22, 1915, contained *Dispharynx* worms indicating that these parasites have been a factor in the decline of the Heath Hen.

Blackhead.—Blackhead is a disease known to be very destructive to the young of such birds as the Turkey raised in confinement but it is rare as far as we know at present, in birds living in a free wild state.

It is definitely established that chickens are common carriers of infection and herein lies the great danger to the Heath Hen. The Heath Hen has the peculiar habit of congregating in the open fields which frequently are near farmhouses where poultry is kept. In most instances chickens and Turkeys have access to the fields visited by the Heath Hen. On the reservation poultry has been kept by the superintendent and in 1923–24 a large flock of Geese had the freedom of the chief drumming field of the Heath Hen. It was not unusual to see the Geese chasing the Heath Hen when contesting for the grain placed around my blind to attract the birds. The droppings of poultry were common and thus ample opportunity was provided for the disease to be handed on to the Heath Hen. According to Dr. E. E. Tyzzer even poultry confined to carefully fenced runs are a danger because of the possibility of distribution of fecal matter, in various ways, to the field visited by the Heath Hen. That this danger of blackhead is real is made evident from a case of this disease in a male specimen trapped on the reservation May 21, 1923. After being trapped it was confined in a pen built among the scrub oaks remote from the poultry. The bird died on May 26 after less than a week of confinement, making it certain that the disease was contracted by the bird while still in a free state. The disease was in an advanced condition there being a large tumor-like growth 46 x 54 x 59 millimeters in size located in the abdominal cavity (Pl. 50). The body was sent to Dr. E. E. Tyzzer of the Department of Pathology, Harvard Medical School, Boston, Massachusetts, for diagnosis, who reported on the case as follows:

"*Heath Hen (Bowdoin No. H. H. 2, Harvard No. 2776) January 12, 1923:*

"There is a nearly spherical mass of tissue measuring from 4.5 to 5 centimeters in its various diameters (*i.e.* about as large as a golf ball) in the body cavity, with loops of the intestine adherent to the dorsal and right lateral aspect. The surface of this mass is uneven, due to fine lobulation, the individual lobulations measuring from 1.5 to 2 millimeters. On section it is found to be composed of an opaque, grayish, slightly yellowish-tinged material interspersed with hyaline, translucent tissue which fills all space between the former; in places the two occurring in alternate layers give such portions a streaked appearance. No lesions were found in the liver or other organs.

"Stained sections show the mass to be composed largely of loose connective tissue with foci of infiltration chiefly purulent but in some portions fibrino-purulent in character. The infiltrated areas are those which appeared opaque on the naked-eye examination. Throughout the infiltrated portions are numbers of Protozoa which correspond in all respects to *Histomonas meleagridis*, the parasite of blackhead

They show the small spherical nucleus, the blepharoplast and in some instances the cytoplasmic filaments characteristic of this parasite. The subsequent dissection of the intestinal loops from the surface of the mass disclosed the fact that the tips of both villi were involved in its substance and that a cavity within the mass connected directly with the lumina of the adherant caeca.

"Diagnosis: chronic blackhead.

"It is evident from the extent of connective-tissue reaction that the disease presented in this case is of long standing. Such a condition could not be produced prior to three or four weeks after the onset of the disease. Notwithstanding the extensive reaction, active infection had been maintained in the infiltrated portions. The absence of lesions in the liver furnishes no proof that this organ was not invaded earlier in the disease. Repair in this organ is often so perfect and the resulting scarring so slight as to be distinguished with difficulty even in freshly killed birds.

"The occurrence of 'blackhead' in an adult Heath Hen furnishes strong presumptive evidence that the young of the species are even more susceptible. Even in a species so susceptible as the Turkey, the disease is not especially prevalent in adults."

During the year 1921, when there was a great decrease in the number of birds, Mr. Keniston and other residents of the island found five Heath Hen which were dead or else in a greatly weakened and emaciated condition. A sick and helpless individual was found in the fall of 1922 and another by Charles R. Barnett in the fall of 1924. Presumably these cases represented disease conditions and emphasize the importance of disease in the recent decline of the birds. In view of these facts and the fact that poultry may act as carriers of disease the State Department of Conservation has removed all poultry from the reservation (April, 1927) and all other sources of infection will be closely guarded.

Though our information concerning the pathology of the Heath Hen is extremely meager, it is enough to indicate that disease is of great importance in our problem of preserving the Heath Hen. The birds are now at such a low ebb that if their natural resistance were lowered by a series of unfavorable conditions, disease would quickly claim the few that remain.

External Parasites.

Heath Hen Louse (Goniodes tetraonis Linné).—Each of nine Heath Hen trapped on Martha's Vineyard during 1923 and 1924 had at least a few and two of the birds had many lice among their feathers. Specimens were identified by Dr. G. Harris, Washington, D. C., as *Goniodes cupido* Giebel but Mr. Oliver L. Austin, Jr., has recently called my attention to the work of Harrison (1916, p. 79) who states that *Goniodes cupido* is synonymous with *Goniodes tetraonis* Linné (1758, p. 614) taken from *Lyrurus tetrix*, the "Black Game" of Europe. The louse was described in 1866 by Dr. C. W. Giebel (1866, p. 387; 1874, p. 195) as *Goniodes cupido* from specimens taken from a Heath Hen secured on Martha's Vineyard. It is well described and figured in Piaget's Pediculines (1880, p. 250–251, pl. 20, figs. 3, 3a). It is very interesting that this louse has survived on the few

remaining Heath Hen. It has also been taken from the Prairie Chicken, *Tympanuchus cupido americanus* (Kellogg, 1899, p. 66; Osborn, 1896, p. 231), but as far as I can ascertain on no other American birds. Since Mallophaga spend their entire life cycle on one host and since their food, temperature and environmental conditions are constant it is probable that *Goniodes tetraonis* has been handed down from birds which were the common ancestors of the Heath Hen and the Prairie Chicken and to these in turn from the common ancestral circumpolar species which gave rise to the Pinnated Grouse of America and the Black Game of Europe. The latter point is purely speculative but the fact that this louse is found on both the Prairie Chicken and the Heath Hen gives weight to the supposition that there was once a continuous distribution of the Pinnated Grouse from New England to the States of the Middle West and that the Heath Hen and the Prairie Chicken are merely geographical races of the same species.

Mallophaga are of little economic importance and apparently do no harm to the host other than to feed on parts of the feathers and dead epidermal scales. In two Heath Hen most heavily infested with lice there was a slightly rough texture to the feathers.

All birds were carefully examined for other external parasites such as ticks and hippoboscid flies but none was discovered.

Excess Males.

A fact which has been noted by other observers and emphasized by the present study (Gross, 1923, p. 468) is the existence of an excess of males. How this abnormal ratio has been brought about is problematical. In a race which has been so greatly reduced in numbers and where there is undoubtedly excessive interbreeding as in our little colony of Heath Hen, it is possible that extreme developments are taking place along certain lines of variation. Sex is thought by certain geneticists to be hereditary and if that is true we may look for the source of this condition in some hereditary influence. There are other factors which may play a part in causing this excess of males. The female incubates the eggs and cares for her young without the assistance of the male. During this period she is always ready to brave dangers in protecting her eggs and young, which she would not consider under ordinary conditions. At such times, therefore, the female is more likely to fall before the attacks of some predaceous Hawk, cat or other enemy than is the male, which has only itself to care for. A similar situation arises in times of fires that occur during the nesting season. The female, as demonstrated by Dr. Field (1913, p. 353), sits very closely when brooding and is very loath to leave her eggs, even allowing a person to stroke her plumage. In case of fire she would probably remain at her post until too late to escape the onrushing flames. The males on the other hand would be able to keep well out of danger from fire. Whatever the cause there is a great excess of

males among the Heath Hen which to the writer seems undesirable. Certain gallinaceous birds are known to be polygamous and from a study of closely allied forms we believe the Heath Hen is not an exception. Under such conditions it would be far better to have an excess of females than an excess of males. No one would think of rearing chickens with a dozen cock birds to every hen, neither is it well that the number of male Heath Hen be in that proportion. The males may molest the females to an excessive degree, tending to produce sterility. Male Ruffed Grouse (presumably other than the rightful mates) have been known repeatedly to attack a nesting female in an effort to copulate and it is reasonable to suppose that this might occur with the Heath Hen. Furthermore it is conceivable that a dozen bachelor males would play havoc with a female tending a brood of downy young.

In 1923 those in charge of the investigation took steps to correct this condition by trapping a number of male birds and keeping them confined. They were placed in pens built among the scrub oaks remote from the poultry of the reservation in order to prevent infection from poultry diseases and parasites. In 1924 four more males were trapped for a similar reason. The traps were placed in widely separated portions of the reservation and it is remarkable that not a single female was trapped, confirming our direct field observations of the prevalence of males. Since 1925 the number of Heath Hen has been so low that further adjustments have not been attempted, but it will be continued if deemed necessary, in the event of the birds increasing to large numbers. From a biological point of view it is interesting that the control of rodents such as rabbits and rats has been accomplished by reversing the process, *viz.*, by capturing and killing all females and liberating all males trapped. Gamekeepers in England and Scotland regularly kill the excess male birds in order to insure the vigor of the stock and the increase in the number of individuals. Similar methods are employed by game breeders who are attempting to propagate gallinaceous birds on a large scale.

Although the importance of the excess male ratio seems very plausible when considered from the standpoint of facts, certain students of the Heath Hen believe that an excess of males is actually beneficial. They emphasize the point that the presence of many males attracts the attention of predaceous animals away from the females. Rabbits have been introduced on the reservation for a similar purpose but whether this is producing the desired effect we do not yet know.

Sterility of Males.

The only evidence we have of sterile male Heath Hens is that obtained by Dr. John C. Phillips during his attempts to breed the birds in confinement. The males failed to boom and to exhibit other signs of breeding. Subsequent dissection revealed that the

testes were undeveloped although it was during the height of the breeding season. He attributed the failure of the birds to breed to the sterility of the males but the conditions of confinement may have been an important factor. It is known that sterility is common among the older males of certain species but there is no certain method of readily obtaining the relative age of a Heath Hen or of determining their virility in the field. If this were possible then in segregating males for adjusting the sexual ratio, the superannuated males should be taken first.

Fires.

Fires which have swept over the breeding range of the birds in the past have played their part in the decline of the Heath Hen. A fire tower has been built near the reservation, fire-stops have been constructed and maintained and all that is practicable has been done to prevent a recurrence of a conflagration such as the one in the spring of 1916. These fire-stops are being continued and greatly extended by the Division of Forestry.

It is difficult to assign a place of relative importance to any one of the series of factors mentioned in the preceding pages because of our lack of information, especially of the conditions under which the birds existed in the past. Species have become extinct presumably because they have been unable to compete with other existing species or unable to cope with changing conditions of the environment. In the case of the Heath Hen, the cause of its decline is probably due to its inability to adapt itself to conditions brought about by man and civilization. Man has changed the character of the habitat of the Heath Hen from the standpoint of its plant and animal life, he has brought disease through domestic fowls and has indirectly developed other conditions unfavorable to the Heath Hen. Today man by expending great effort in correcting or controlling certain of these adverse conditions may prolong the life of this interesting species but it is extremely doubtful if it can ever be restored to numbers where it will be of economic importance. His efforts to save this species must be made from purely sentimental motives.

Field Notes.

Martha's Vineyard from the Fire Tower.

From the top of the fire tower built by the Forestry Department one may gain a splendid impression of the reservation and of the general character of the island. The large area of sandy plains grown up to scrub oaks, the home of the Heath Hen, can be seen from this vantage point. It is among these thousands of acres that this bird is making its last desperate stand for existence. My first impression of this great expanse was little more than an uninteresting waste, but after I had lived in the land of the

Heath Hen for some time I found a lure and attractiveness about it that I could not at first appreciate.

To the eastward from the tower the fields of the reservation stand before one like a map. The large meadow where the birds come to feed and to go through their courtship performances is between the tower and the home of the superintendent. Extending westward from the northern edge of the meadow for a distance of about three fourths of a mile is a fire-stop which was built several years ago as a barrier against fires which have proved so destructive in the past. In recent years the cleared area comprising the fire-stop has been used by the Heath Hen as an accessory feeding ground. To the westward the scrub oaks stretch away for miles with scarcely a break to the hills of West Tisbury and Chilmark. To the northward, on a clear day, you can plainly see the boats anchored in Vineyard Haven over four miles away, and across the Sound the faint outlines of the mainland at Menanhant in the town of Falmouth. If you focus your glass on the Sound you may see a passing ship or a tug-boat plowing along with two or three heavily laden barges. To the right of Vineyard Haven is the water-tower of Oak Bluffs, a conspicuous landmark in that part of the island. Beyond this tower is Hethern Heights which in former times was inhabited by a large number of Heath Hen. Following the horizon farther to the right you get a glimpse of Nantucket Sound and then around to the south-eastward you can see the church spires and taller buildings of Edgartown peering above the trees. You cannot see the ocean in that direction because of the distance and the low-lying hills which intercept the view. To the southward you catch glimpses of the blue sea along the greater part of the shore line as well as many of those remarkable fresh-water ponds, famous for their goose- and duck-shooting, that are separated from the ocean only by very narrow bars of sand. The sand bar that separates Tisbury Great Pond can be readily distinguished from the top of the tower on a clear day. This sand bar is the home of the Least Tern and many Common Terns and Piping Plovers nest there. As you follow the south shore to the westward you soon sight the high cliffs that mark the shore of Squibnocket Pond. From this point around the compass to Vineyard Haven the ocean is hidden from view by the beautiful tree-covered hills of Gay Head, Chilmark and Tisbury.

When you examine the miles of scrub oaks that occupy the center of the island you readily note the very uneven surface caused by the interspersal of the taller black and white oaks which at present range from four to ten feet in height. The scrub-oak growth which occupies the bulk of the area is less than three feet in height. As one views these plains from the top of the tower there seems to be little more than the oaks already mentioned but when I traversed them on foot in quest of the Heath Hen I met with a diversity of shrubs and plants. In certain places there were dense growths of aspen,

black alders and gray birches with here and there a few scraggly specimens of scrub pine. More rarely a *Crataegus* and a wild-cherry tree were seen. There were numerous patches of sumac and on the plains bordering the south shore impenetrable thickets of bayberry more or less overgrown with tangles of vines. All through the scrub oaks there were masses of sweet fern and blueberries and huckleberries abounded everywhere.

The Reservation in April.

My study of the Heath Hen began on April 9, 1923. As I traveled on the train from Boston to New Bedford on the way to the island I noticed patches of snow in the woodlands and every brook and river was swollen by the water accumulating from the melting snow. On Martha's Vineyard the snow was all gone and the four miles of road from Vineyard Haven to the reservation were dry and in good condition. The vegetation at that time exhibited no marked signs of life, but the numerous Fox Sparrows and a Phoebe gave evidence that winter was giving way to spring. In April the plains were a study in grays and browns. The "drumming field" of the Heath Hen was a dull creamy gray and stood out in marked contrast to the darker colors of the scrub oaks. Many of the oaks still retained their leaves of the past year and these gave the landscape a distinctly reddish-brown appearance.

During all of my visits to the reservation I enjoyed the hospitality of Mr. Keniston's home which was pleasant, comfortable and most convenient to one of the drumming fields of the Heath Hen. At that time (April, 1923) the birds came regularly to a definite part of the meadow west of the house. A wooden blind four by six feet, and six feet high, had been erected several years before for the convenience of the large number of bird lovers who came to the reservation each year to see the Heath Hen. It was covered with corn stalks the first year after it was built to make it less conspicuous but later this was found to be unnecessary. The blind became a part of the environment of the drumming field around which the birds came to enact their courtship performances without any apparent fear of being harmed. The birds even favored me by alighting on the roof, offering the best opportunity to study the intimate details of their interesting behavior. Corn was distributed near the blind as an added inducement. In order not to disturb the birds it was necessary to enter the blind before the light of day for the morning observations, and there patiently await their coming. It is impracticable to use more than a very few of my field notes; therefore I have chosen from my notebooks the detailed records of only two days, April 11 and May 15, which are typical of the conditions that existed at the reservation during those months of the year. The times of the day are given so that the reader may easily follow the sequence of events and all notes are included to assist in visualizing the experiences I had with the Heath Hen and

other birds present on the scene. Following these notes is a description of the conditions found in summer.

April 11, 1923, 3:30 A. M. It is very dark and only the faint light of the stars illuminates my way to the blind located in the western meadow about one fourth of a mile from the reservation house. There is a heavy frost and the grass crunches under my feet as I walk along. All is quiet as far as the voices of birds are concerned.

3:40 A. M. I am now seated in the blind waiting for the birds to appear. A fog has been coming in and at present is dense enough to hide the stars.

3:55 A. M. First dim light of dawn. I hear the first clear whistled notes of a Bobwhite perched somewhere among the scrub oaks to the northward.

4:05 A. M. The first Robin begins chirping.

4:10 A. M. A Vesper Sparrow is singing its awakening song.

4:15 A. M. I can now see the outlines, but very little detail of the trees along the margin of the meadow. The Song Sparrows have joined the morning chorus which is increasing as the dawn approaches.

4:20 A. M. The challenge of the first Bobwhite has been answered by three others, giving evidence that this little game bird is becoming well established on the reservation.

4:21 A. M. The first toot of the Heath Hen is heard in the distance near the western margin of the meadow. It is not yet light enough to see and the fog obscures the view.

4:24 A. M. The toot is followed by hen-like calls resembling *cac-cac-cac.*

4:27 A. M. A Heath Hen appears from the scrub oaks on the south, which are not very far from my blind, and immediately starts tooting.

4:30 A. M. I can now see two birds along the southern border of the field and their calls have stimulated the birds to the westward to greater activity in tooting.

4:45 A. M. A third bird has appeared on the south. I cannot as yet see the birds to the westward because of the fog, but I can plainly hear their answering calls and toots.

4:50 A. M. It is growing lighter. One of the birds has flown to the roof of my blind where I have placed corn to attract them. The blind apparently, was first chosen by the birds as a vantage point from which to view the field and as an admirable place to conduct their stamping and tooting performances.

4:53 A. M. The bird on the roof is now eating corn. The two other birds which are near the scrub oaks on the south are busy feeding but are gradually making their way toward the blind. Their feeding, however, is frequently interrupted by their tooting or so-called booming *whhoo-ooo'dle-doooooh!* followed by the hen-like, *cac-cac-cac* or *oc, oc, oc, goc, goc, goc,* occasionally ending with a queer call which might be represented by *auk, a-e-e-e-e-ek* and sometimes it is more nearly *e-e-e-ek-ek-ek-ek.* Frequently one of them leaps into the air to a height of three or four feet and in so doing utters a loud

piercing *urrrrrrrb* followed by a curious laughter-like sound. In this wild demonstration the bird completely reverses its position so that it faces in the opposite direction from its initial position when it alights on the ground. This leaping and screaming seems to be augmented by similar performances of the members of the group somewhere in the western part of the meadow.

4:58 A. M. The bird on top of the blind has just stamped its feet and tooted and while so doing I could clearly see it through a space between the roof boards.

5:00 A. M. The sun which is well above the horizon has just appeared through the fog as a great red ball. The Quail have ceased calling, the chorus of Robins has diminished but the Song and Vesper Sparrows are singing as vigorously as ever.

5:01 A. M. The Heath Hen in the western part of the field can be plainly seen and are now approaching the blind.

5:02 A. M. One male from each group runs rapidly toward another male in a defiant war-like attitude. When near together they hesitate, lower and waver their heads, leap at each other and strike their wings vigorously as they leap. Apparently no harm is done and they settle back into a comfortable position facing each other.

5:03 A. M. One of the birds has arisen, has run away a short distance and is now going through his tooting performance without any interference from his antagonist.

5:07 A. M. Something has frightened the birds, though I cannot determine what it is. The bird on top of the blind and all except one of the birds on the ground have flown from the field to the scrub oaks.

5:16 A. M. Two birds have returned from the oaks and alighted near the blind, later joining the bird which did not leave the field. These birds are now active in their tooting and mock fights.

5:30 A. M. A Vesper Sparrow has alighted on my roof and his song which is being sung not more than a few inches from my head is one of the finest I have ever heard from this pleasing little Sparrow. Its complete song is being uttered six to eight times every minute.

5:48 A. M. A Heath Hen has flown to the top of the blind and, somewhat to my regret, the Vesper Sparrow was forced to give right of way to the larger bird. The other two Heath Hen are now busily engaged in feeding but all the time are approaching nearer and nearer to the corn distributed around the blind.

5:51 A. M. Four more birds have come on to the field making seven in all.

5:55 A. M. The bird on top of the blind is pecking at the corn and makes a great deal of noise as the ears are rolled about. At irregular intervals whenever the occasion seems to demand, the bird goes through his tooting performance; at other times he merely rests quietly near the edge of the roof apparently interested in his fellows or the general land-

scape. The two birds which are now near the blind are taking their turns at eating corn. The birds seem suspicious and are ever on the alert and do not trust themselves near the blind for any great length of time.

5:59 A. M. The four birds which appeared last are actively feeding on something among the grass of the meadow, probably sorrel or clover.

6:25 A. M. One of the males of the above group is running after the other which has taken flight. The other birds have followed and all are flying into the scrub oaks.

6:30 A. M. The sun is brighter and the fog has been completely dispelled, but a chill wind has started up. One bird still remains on top of the blind and I am getting some very fine views of him through a reflecting mirror offering unexcelled opportunities to study its vocal mechanism. The stamping which precedes the tooting and which seems like a very minor part of the courtship performance when it takes place on the ground, is one of the chief features when the resounding pine boards directly over my head intensify the sounds. Two birds are feeding on the ground near to the blind.

6:45 A. M. The bird on the roof for no evident reason flies away and the two birds on the ground follow, flapping their wings vigorously as they sail off into the seclusion of the scrub oaks to remain until the afternoon performance.

7:00 A. M. Now that the excitement of watching the Heath Hen is over I realize how stiff and cold I am even though I am dressed in the heaviest of winter clothing.

7:30 A. M. I remained in the blind until 7:30 to make sure the birds would not return. After being away from the field for this length of time experience has shown that the birds are not likely to return again until the afternoon, especially when there is such a strong sharp wind. I left the blind feeling cold but well rewarded by the rich experiences of the morning.

Afternoon of April 11, 1923; 2:00 P. M. Arrived at the blind. Temperature 40° F. It is rather hazy and there is a cold east wind. Canada Geese, which are being kept at the reservation, have been about the blind eating corn. I regret that these Geese are allowed to interfere with the activities of the Heath Hen for there are times when the Geese and the Heath Hen are on the field at the same time I have even seen the Geese chase the Heath Hen but it is interesting to note that certain of the more pugnacious males sometimes bravely turn on the large hulks and put them to rout. The worst feature of the presence of these Geese and other poultry is the danger of transferring disease through the excreta. (When the attention of the Director of Fisheries and Game was called to this condition the Geese were removed from the reservation.)

3:00 P. M. The sun is now casting a dim shadow. Several Crows have been flying over and three Mourning Doves have appeared on the field. Aside from these few birds, the place seems deserted since the Geese have gone away.

3:15 P. M. The sun is shining brightly now and this combined with a sharp wind will probably delay the birds. On still cloudy days I have seen birds feeding and tooting on the hill at noon time, but if the sun comes out bright they become quiet and soon skulk off to the woods.

3:45 P. M. Without any announcement nine Heath Hen appeared on the field and at once began a series of *cac-cac-cac-aeck* calls which were soon followed by tooting.

3:50 P. M. The birds are flying about a great deal at present. The disturbance seems to be caused by an ambitious male who insists on chasing one antagonist after another, following them rapidly on foot until they take to their wings. He flies after them for a distance of thirty or fifty yards then circles and returns to repeat the performance with another weaker member of his group. Some of this appears much like play among boys just out of school.

4:05 P. M. The birds have now settled down in a comparatively small area and six of them are paired off against each other. They are not fighting at present but are crouched in the grass in a seemingly motionless posture. In the case of one pair the bills of the birds are not more than ten inches apart. Occasionally they utter subdued *aek-aek-aek* sounds which at times are raised in pitch and intensity.

4:08 P. M. Suddenly without any provocation one of the birds has lunged at his antagonist who merely steps back and holds his ground. Both seem afraid of each other; it proves to be a draw and there is not the usual mock battle. Both birds have started tooting. With this beginning the other birds start a vigorous performance. One bird has rushed toward the blind and is performing for me not more than six feet away. The pinnae of this bird are not always thrown forward but sometimes they are held upright or even backward at a slight angle when the sacs are being inflated. They are not always coördinated but the pinna of one side may be forward and the other backward. (These pinnae are controlled by voluntary muscles and can be moved freely at all times and not merely during the tooting performance.)

4:15 P. M. A Heath Hen has alighted on the roof and is feeding on the corn.

4:20 P. M. One of the birds on the ground has walked toward me and is feeding on the corn distributed at the base of the blind.

4:25 P. M. The bird on the roof has ceased feeding and is now perched on a slightly projecting board. It utters an almost continuous series of low subdued notes which might be represented by *gaw-gaw-gaw*. Although the bird is very near, these notes are barely audible. Through a crack I can see that the chin or gular area moves up and down as the notes are produced. The bill is tightly closed.

4:30 P. M. The bird on the roof flew down to join its fellows in feeding on the corn about the base of the blind. The birds prefer corn on the cob to that which is shelled

for them. They pick at the corn with such vigor that the entire ear is moved and is sometimes lifted from the ground. Took several pictures with the protar lens.

4:32 P. M. The birds are walking away quietly, feeding as they go upon the leaves of sorrel which grows in abundance among the grass.

5:00 P. M. All of the Heath Hen are busily engaged in feeding and are paying no attention to one another. I have heard no notes from them during the past half hour.

5:05 P. M. A Hawk has just swooped across the field. For an instant one of the Grouse stands erect and utters a characteristic alarm note and then all assume a motionless crouched position in the grass. When so crouched the birds blend in perfectly with the dull colors of the weathered grass.

5:10 P. M. I hear faintly the booming of a Heath Hen in a distant field.

5:20 P. M. Birds on the field near me start *cac*-ing calls and a few tooting performances are rendered.

5:30 P. M. The tooting has ceased and the birds are working their way toward the scrub oaks on the south.

5:45 P. M. The sun is now a fiery ball as it peers through the hazy atmosphere. The red rays strike through every crack and knot-hole of the blind to illuminate the interior. Such cross-lighting is very troublesome for any movement which I may make is readily detected by the Heath Hen which are ever on the alert for motion. Sounds of the camera or even my voice do not seem to disturb them in the least. Often when I wish to secure a certain pose of a bird near the blind I talk to him and usually get the desired results. On the other hand if a human being appears on the horizon they are all off like a shot.

6:10 P. M. The sun has just sunk behind the fringe of scrub oaks beyond the fire tower.

6:15 P. M. All the Heath Hen walk into the scrub oaks and disappear from view. The wind has died down and I do not feel cold as I did earlier in the afternoon.

6:30 P. M. I left the blind in the glow of the April twilight.

The Reservation in May.

In May the scrub oaks have changed from the brown tones seen in April to a decided tinge of red. A close inspection reveals that this color is due to the hundreds of Van Dyke-red catkins. The meadows have changed from gray to green and leaves are appearing on many of the shrubs and trees. The progress of the vegetation is less advanced than in Boston; it is more like the conditions found in Maine at this time. The following notes, taken on May 15, 1923, are typical for that time of the year.

May 15, 1923; 2:45 A. M. Temperature 39° F. Very foggy and dark.

3:00 A. M. The first Whip-poor-will call of the morning and the first I have heard this season.

3:20 A. M. A Robin starts chirping and a few minutes later is joined by several other individuals.

3:30 A. M. The Robin chorus has reached a great volume, the songs seeming to come from every section of the reservation. I am now leaving for the blind.

3:35 A. M. I can see the outlines of the trees as I walk along but not clearly because of the fog. The Starlings are active about the nesting boxes attached to the telephone poles along the roadway leading to the blind.

3:38 A. M. The reservation Geese are making a great commotion with their honks and calls.

3:40 A. M. I am entering the blind to await the coming of the Heath Hen.

3:46 A. M. After several weak attempts, a Brown Thrasher bursts into full song.

3:50 A. M. First song of the Song Sparrow.

3:56 A. M. First Chewink call-note. The light of dawn is sufficient so that I can see a little of the detail of the trees.

3:57 A. M. About four or five Blue Jays are making a great disturbance over in the scrub oaks north of my blind.

4:04 A. M. The Guinea-hens, the noisest creatures on the reservation, have started and are now adding their din to the morning chorus which is rapidly reaching its maximum volume.

4:06 A. M. First Heath Hen heard tooting.

4:07 A. M. Second tooting heard but I cannot see the birds because of the fog and dim light.

4:10 A. M. I can now see the forms of two Heath Hen approaching the blind.

4:11 A. M. What seemed to be a Short-eared Owl has flown by noiselessly between the Heath Hen and the blind. The birds stopped momentarily but soon continued, seemingly little concerned about the Owl's sudden appearance.

4:15 A. M. A Heath Hen alighted in a scrub-oak tree at the edge of the field and cackled several minutes before settling down.

4:20 A. M. The two birds which had been near me have now retreated to the western end of the field when several tame Geese appeared around the blind to feed upon the corn.

4:45 A. M. The bird perched in the tree has maintained its same position during the past half hour. It does not utter any notes but is constantly turning its head from one point of the compass to the other as in constant fear of being attacked. It may have had an experience with the Owl which flew by the blind earlier in the morning.

4:50 A. M. The Quail, Red-winged Blackbirds, Chewinks, Vesper and Field Sparrows are singing at the present time.

5:00 A. M. There are now two Heath Hen perched in the tops of the scrub oaks.

5:12 A. M. A Crow has alighted in a tree near the first Heath Hen but neither his presence nor his lusty cawing seems to excite them.

5:15 A. M. The first Heath Hen has now been in the tree for an hour and though it has frequently raised and lowered its body and sometimes elevated its head it has remained on the same perch.

5:20 A. M. Four Heath Hen on the field have been actively feeding.

5:30 A. M. They have started tooting but not with a great deal of enthusiasm.

5:50 A. M. The tooting and cackling have stopped.

6:00 A. M. The mist has been dispelled and the sun is now shining brightly. The bird chorus has greatly diminished in volume.

6:15 A. M. All of the Heath Hen are leaving the field and as they fly over the two birds in the tree join them. I left the blind at 7 o'clock.

May 15, 1923; 3:00 P. M. There are many Barn and Tree Swallows skimming over the meadow as I walk to the blind this afternoon. The Field Sparrows are in evidence among the shrubbery growing near the roadside.

3:20 P. M. A Vesper Sparrow has alighted on the roof of the blind to sing and I am wondering if it is the same individual that made me regular visits during the month of April.

3:30 P. M. There are several Robins on the field; one individual near the blind is tugging at a long grass stalk, a prospective piece of nesting material.

4:00 P. M. There are various song birds on the field but there is no sign of a Heath Hen.

5:30 P. M. No Heath Hen have appeared so I am leaving the blind. The birds have been appearing regularly in the mornings but their appearance in the afternoons has been very erratic. (After this date the birds did not appear in the afternoons.) The birds are probably finding a certain amount of food elsewhere and furthermore these males show less enthusiasm for the tooting performance as the season progresses.

The Reservation in June.

After the middle of June the drumming or tooting field is deserted by the Heath Hen. It is then grown up in tall grass, weeds and flowers. When I visited the reservation in June a view in any direction from the blind on the hill revealed a sea of ox-eye daisies on which every gust of wind sent miniature waves of nodding heads across the field. The daisies grew so thickly in some places that all other plants were hidden from view, but

here and there were island-like patches of red clover and purple blossoms of the hairy vetch which made striking combinations with the white and yellow of the daisies. In certain portions of the field there were large clusters of yarrow and on the lower levels were magnificent spikes of the blue-weed towering high above the grasses. Among patches of ribbed grass and timothy there were fuzzy lavender heads of the rabbit-foot clover and here and there masses of the yellow and white clovers. The leaves of these plants were sought by the Heath Hen when they visited the fields in April and May. On the hillside facing the reservation house I found tangled masses of potentilla intermingled with myriads of wild strawberry vines which in June were laden with an abundance of small but delicious fruit. As I approached the margin of the meadow on the south to enter the scrub oaks I met with the white campion, the brilliant yellow but delicate flowers of the frost weed and numerous blossoms of the tall crowfoot. There were dozens of other flowers to attract the casual observer and a botanist could spend much time with profit studying the host of interesting plant forms growing on the great stretches of those sandy plains. As soon as the blossoms of June faded others took their place and by the first week of July a host of new forms appeared. Perhaps the most striking of them all was the gaudy black-eyed Susan which was in evidence in all parts of the meadow.

During the heat of the day in June the Barn Swallows which built their clay nests on the rafters of the reservation barn could be seen skimming over the fields in quest of insects for themselves and young. On every telephone pole along the roadside which borders the western field is a bird box and many of them were inhabited by the Bluebirds and Tree Swallows. The Starlings were also competitors for the houses but the latter like the English Sparrows are given no encouragement to remain on the reservation. The Vesper and Grasshopper Sparrows built their nests in the grass of the drumming field and though the Redwings were frequent visitors here I never found evidence of their nesting. It seemed like an ideal place for the Meadowlark but I never saw or heard one while I was on the reservation. In the scrub oaks, especially along the margin of the fields, there was always a host of birds to be seen during the nesting season. Here I found the Brown Thrashers, Catbirds, Song and Field Sparrows nesting. To me the Chewink and the Prairie Warbler stand out prominently among the characteristic birds of the scrub-oak plains. The Quail nested in the sweet fern and grasses among the oaks and many of them frequented the meadows especially in the early morning and the latter part of the afternoon up to sunset time. Quail have recently been introduced at the reservation and they are now gaining a strong foothold. One evening while making observations from a blind eight males were heard from different quarters at the same time. When I traversed the fields with a dog in search for Heath Hen, pairs of Quail were frequently pointed by the dog. Usually the male Bobwhite mounts a fence-post or

a limb of a dead tree to announce his name but at the reservation I noted very frequently that the birds would call from the ground. They would pause in their feeding, mount a clod or a stone to gain a vantage point, and there send out a challenge to their fellows in other parts of the field.

During the summer after the young have hatched, the mother Heath Hen frequently visits the dirt roads which traverse the plains, for a dust bath. Now that the birds are so greatly reduced in numbers one is very fortunate if he finds a brood. Although I remained at the reservation all summer traveling many miles on foot and by car each day, I saw but fleeting glimpses of two small broods about one fourth to one half grown which were taken unawares as we bounded along the isolated roadways in a Ford car.

In the fall and winter the birds congregate but more or less erratically in the fields to feed and may again be seen by the visitor who comes to the reservation, but with less certainty than in the spring.

Courtship and Notes of the Heath Hen.

The courtship of the Heath Hen is a most extraordinary performance. Its striking and unusual features have served to attract scores of bird lovers who journey to the reservation each year to see the remnant of this vanishing bird. The tooting or drumming is a most important feature of the ceremony but like most notes it is not possible to describe it so adequately that the reader will gain a clear conception of its character and quality. One must see and hear the Heath Hen on its drumming field to claim an acquaintance with this unique bird. If the Heath Hen continues to exist, as we all earnestly hope it may, the bird student will not find it difficult to see this bird perform. It is best to go some time between the first of April and the second week of May for at that time the courtship is at its height. In order to see the performance it is necessary to enter the blind on the drumming field before the first light of dawn. The morning chorus of song birds which you will hear on the reservation is in itself well worth the effort to arise at the early hour, and serves to hold your interest until you hear the toot of the Heath Hen, the main objective of your trip. When the tooting is heard in the distance the listener who is at the reservation for the first time, does not readily associate the sound with that of any bird. One can easily be lead to believe that the sounds are those of distant tugboats worming their way through the fog off the coast of the Vineyard. Though I was well prepared for this deception I shall admit the first tooting noise I heard did not suggest the Heath Hen. But as the birds came nearer the blind through the uncertain light, the source of the sound was less deceptive and I recognized a peculiar quality which gave it a distinct individuality.

The number of notes in any one performance varies considerably and each time that

you go to the reservation you will probably make a slightly different interpretation of the tooting. One of the common representations which I find in my notes is *whhooo-doo-doooohh* but as I listened to frequent repetitions under different conditions from day to day I became impressed with the infinite number of minor variations and it became increasingly difficult to represent them properly. Some of the more common transliterations are: *whoo-oodul-dooo-o-o-o; whoodle-dooooh; whoo-dooh doooh.* The sound is best imitated by puckering the lips as if preparing to whistle and then uttering the syllables represented above in a muffled tone. The sound increases in intensity on the second syllable or the first part of the second and then gradually dies away. I have heard a well-known naturalist and student of the Heath Hen give a very nearly perfect imitation of the note by blowing across the mouth of an empty two-drachm vial. By means of a stop-watch it was determined that it requires one and one-half to three and one-fourth seconds to utter the different versions given above. The number of toots and calls given per minute varies greatly according to various factors such as temperature, weather conditions, time of the day and season. The following record taken of a very active individual on the morning of May 14, 1925, beginning at 3.55 A. M., is of interest for it serves to illustrate the frequency of these calls under ideal conditions when the bird was stimulated to action by other males. The numbers indicate the number of seconds which elapsed between the successive toots and cackles.

Toot, 15, toot, 12, toot, 9, toot, 11, toot, 9, toot, 8, cackle, 6, toot, 11, cackle, 7, toot, 8, toot, 10, toot, 10, toot, 24, toot, 26, cackle, 8, toot, 13, toot, 15, toot, 5, toot, 15, toot, 9, toot, 9, toot, 11, cackle, 12, toot, 8, toot, 9, toot, 18, cackle, 11, toot, 7, toot, 7, toot, 13, toot, 15, toot, 9, toot, 10, toot, 14, toot, 24, toot, 9, toot, 33, cackle, 5, cackle, 9, cackle, 10, toot, 21, toot, 11, toot, 4, cackle, 21, toot, 7, cackle, 2, toot, 7, toot, 11, toot, 10, toot, 2, toot, 40, toot.

The tooting and other calls are not given at all times of the day but are uttered chiefly during the hours following the first light of dawn and again during the latter part of the afternoon. If it is very dark and cloudy the birds may be heard tooting during the middle of the day, but it is unusual to hear them at this time if the sun is bright and hot. The atmospheric conditions have much to do with the vigor of the performance; if it is cold and windy (a usual condition on Martha's Vineyard in the early spring) the birds are less active than when it is still and moderately warm. One of the best performances I ever witnessed was on a still morning in April when the meadow was enshrouded in a heavy fog. Even a slight rain does not seem to dampen the ardor of their performance. The booming or tooting as correlated with the time of day and the part it plays in the morning bird chorus on the reservation, as well as other notes and calls of the Heath Hen, can be obtained by a review of the typical field experiences given in the preceding section of this paper.

The tooting is usually prefaced by a short run followed by a very rapid stamping of the feet, a part of the performance which is not readily detected unless you are near to the birds. The stamping is vigorous enough, however, to be distinctly heard for a distance of twenty-five or thirty feet and certain males which did their stamping on the resonant wooden roof of my blind produced a noise that was second only to the tooting that followed. In preparation for tooting the neck is stretched out forward, the pinnae (neck tufts or wings) are usually directed upward or forward, the primaries are spread and held firmly against the body and legs and the tail is thrown up at right angles to the axis of the body, thus displaying the white under tail-coverts when viewed from the rear. During this procedure the whole musculature of the body seems to be in a strained state of contraction as if it required great effort on the part of the bird. As the inflation of the orange-colored sacs (it is really one large sac with two lateral, orange-colored patches devoid of feathers) begins, the tooting sound is heard. Sometimes there is a slight inflation before any sound is given. The inflation is uniform and does not fluctuate with the inflections and accents of the tooting call. At the end of the tooting the sacs collapse suddenly by the release of air through the nares or more rarely through the opened mandibles. The sacs do not produce the sound during deflation, as was thought by some ornithologists (Jasper, 1874–78, p. 81; Brooks, 1847, p. 240), but they have much to do in modifying the sounds produced by the syrinx. The syrinx, as in all birds, is a vocal mechanism located at the junction of the bronchial tubes. The sounds are produced by the air forced from the lungs which vibrates specialized membranes of the syrinx that are under the control of a complex system of muscles. The sound waves then issue out through the trachea and glottis to the pharynx and in ordinary notes such as the cackle the mandibles are opened and the air accompanied by the sound waves issues out of the mouth. In the subdued *gaw-gaw-gaw* notes mentioned on page 537 the mandibles are closed, but the gular patch distends when the notes are emitted, thus producing a kind of muffled effect. In the tooting performance the mandibles are tightly closed, the gular area is elevated and the tongue forced against the roof of the mouth (palate) by the mylohyoideus muscles to close off the exit through the internal nares. The tongue is bent in such a way that it causes the glottis at the base of the tongue to open directly in front of the oesophagus. The air now coming from the respiratory system is forced to fill the modified anterior end of the oesophagus or gullet which becomes distended like a miniature balloon. While this curious sac is filling, the sound waves produced by the syrinx beat against these tense drum-like membranes which serve as resonators for the sounds and give them their great carrying power. Sometimes a male bird is disturbed by another male when the former is in the midst of tooting. On such occasions the bird's mandibles may be suddenly opened and instead of the tooting

sound, a loud weird squawk results. The ordinary cackles and screams of the Heath Hen seem louder than the tooting sounds when one is near but at a distance of a few hundred yards or more you can hear none of these calls, whereas the tooting sound carries distinctly for a long distance. On certain mornings when I was on the Willis Plains I could distinctly hear the tooting of the birds on the western field more than a mile away.

This peculiar modification of the gullet is also found in other birds, for example, the familiar guttural pumping note of the American Bittern, "Thunder Pumper," is produced by a similar mechanism. Further details of the structure of the vocal organs will be found on pages 571–573.

The tooting of the Heath Hen may be heard during the spring from the first week of March to about the time the young birds make their appearance. There may be no correlation between these facts that is significant but the male ceases all of his courtship performances by the middle of June. It has been reported as being heard at other seasons of the year but if so it is unusual. Mr. Keniston has never heard it at times other than the spring, and during my visits to the Vineyard I did not hear the birds toot after the middle of June. Mr. Keniston who has kept careful records of the activities of the birds has provided the following dates when the birds were heard booming for the first time during the respective years:

1919, February 24	1923, March 2
1920, March 8	1924, February 27
1921, March 4	1925, No record
1922, March 3	1926, March 9
	1927, February 12

In 1915, when there was a large number of birds on the reservation (estimated at two thousand), Mr. William Day heard the first boom or toot on February 22, about the same time as in recent years when the numbers have been greatly depleted. The last date is much more difficult to secure and furthermore Mr. Keniston was not always able to keep daily records in June because of the pressure of other work at the reservation. The following records are available:

1918, June 9	1923, June 11, (author's record) at the reservation
1920, June 20	1926, June 2, Keniston's record at the reservation
	June 5, McLeod's record at Green's farm

Behavior of the Female.

During the first year (1923) that I spent at the reservation all of the birds observed were males. In 1924 there were three females on the reservation and in April, 1926, there were at Green's farm two females, a study of which forms the basis of these notes.

The females seem to be very indifferent to the attentions of the males. The three females observed on the reservation in 1924 always remained in a group well apart from the male members of the flock. In 1926 on the Green farm the females came to the field and left with the males and at all times seemed to be in more intimate association than those observed in 1924. The females, however, were very indifferent to the attentions of the more aggressive sex. When a male or a pair of males came strutting and circling about a female she kept on with her feeding. If the males came too near she merely stepped to one side and continued with the serious business of securing food.

I never saw an act of copulation among the Heath Hen and Mr. E. H. Forbush who has visited the reservation over many years and at times when birds were very abundant, has never observed it. I have seen the Prairie Hen copulate on the open fields of central Illinois where such an act was a signal for all of the males in the vicinity to rush to the scene to dismount their fellow cock.

I have never heard the females utter a single note on the drumming field but they give calls and notes when attending their young. If the female is suddenly surprised she gives a characteristic sharp call-signal for her young to scatter and hide. If the brood is young and unable to fly she feigns a wounded bird and cries out as if in great pain as she flutters along the ground. If the young are older she usually sails out over the scrub oaks uttering a loud cackling call which apparently is also for the purpose of attracting attention away from her young.

Nest, Eggs and Young.

The nest of the Heath Hen is built on the ground and is usually composed of leaves, grasses and twigs already in place, to which may be added materials found near the nesting site. The Prairie Hen of the Middle West selects an exposed site among the grass of the open fields (Pl. 45, fig. 20) but the Heath Hen chooses a spot well concealed by the dense vegetation of the scrub-oak plains. Indeed, the nests of the latter are so well hidden from view and the eggs so well covered when the bird is away that very few nests have been found in spite of the great efforts various observers have expended to locate them. During the nesting season of 1923 I spent much of my time each day struggling through many miles of scrub oaks with a trained bird-dog, but I never succeeded in finding a nest. A very liberal reward offered to the islanders also failed to bring results. In the past, even when the birds were present in large numbers only a very few nests were found. In Forest and Stream, William Brewster (1890, p. 188) states: "Only one person of the many whom I questioned on the subject has ever seen a heath hen's nest. It was in oak woods among sprouts at the base of a large stump, and contained either twelve or thirteen eggs. The date, he thought, was about June 10." There is a set of eggs in

the William Brewster Collection now a part of the collection of the Museum of Comparative Zoölogy. The label accompanying this set reads as follows: "Martha's Vineyard, Mass. July 24, 1885. Collected by a young man who lives at Cottage City, Martha's Vineyard. Collector said he found the nest in woods near Gay Head. Collector brought them unblown to C. J. Maynard, July 24. They were on the point of hatching and Maynard saved them with great difficulty [Mr. Outram Bangs of the Museum of Comparative Zoölogy assisted Mr. Maynard in saving these eggs]. The set is described and one egg is figured by Capen [1886, p. 82]. I paid $4.00 for the set." The set originally contained six eggs but one egg was given to the National Museum. The egg in the National Museum, Number 23945, is figured in Bendire's Life Histories of North American Birds, Plate 3, fig. 2. Bendire states that the six eggs referred to above are the only eggs in any collection known to him. There is an egg in the Brewer Collection of the Museum of Comparative Zoölogy marked *Tympanuchus cupido*, Holmes Hole, Massachusetts (Holmes Hole is the old name for Vineyard Haven), which is undoubtedly an egg of the Heath Hen. Another egg in the same collection has printed on it "*Tetrao cupido*, Osage Village—16 in nest." In Baird, Brewer and Ridgway (1874, p. 440) there is a description of three eggs under *Tetrao cupido*, which came from a nest containing sixteen eggs found at Osage Village, Indian Territory. This egg therefore is not of the Heath Hen but of the western form *americanus*.

In 1906 Mr. E. B. McCarta located a nest and nine eggs in a low but dense growth of scrub oak on Martha's Vineyard. Dr. George W. Field photographed the nest on June 2 (Pl. 45, fig. 19) and two days later the eggs were placed under a bantam hen. On June 20, when one of the eggs hatched, the chick was killed by the hen; the other eggs failed to hatch. This set of eggs with the chick is now a part of a display group in the American Museum of Natural History, New York.

On June 5, 1912, Deputy Warden Leonard after a most prolonged and diligent search found a nest with four eggs covered with leaves. The nest was in a slight hollow among a dense mass of sweet ferns growing among the scrub oaks. The oaks in the vicinity of the nest were about two to three feet in height. When the nest was visited on June 12 the bird was incubating. On June 21 Dr. Field was able to determine that there were eight eggs and a week later he secured an excellent series of photographs of the bird on the nest (Pl. 46, fig. 23). The bird sat so closely on the eggs that it was dislodged only by active effort. Deputy Leonard had no difficulty in approaching the bird and she fought the approach of the hand in the same manner as would a sitting hen, ruffling her feathers, opening her beak and striking viciously. This attachment for her nest indicates why forest fires have been so destructive to the species. The incubation period of the Heath Hen, according to Dr. Field, is twenty-four days. The eggs of the Ruffed Grouse require

about the same time but according to Kline the incubation period of the eggs of the Prairie Hen is only twenty-one days. In addition to the eggs noted above there is an egg of the Heath Hen in the John E. Thayer Museum and another in the collection of the Boston Society of Natural History. The latter is an egg that was picked up on the plains of Martha's Vineyard after the destructive fire in 1916. The above represent, as far as I know, all of the eggs of the Heath Hen to be found in collections at the present time.

Bendire in his Life Histories of North American Birds (1892, vol. 1, p. 93) describes the Heath Hen eggs as "creamy-buff in color with a slight greenish tint, ovate in form and unspotted." Elwin A. Capen (1886, p. 82), describing the six eggs of the Brewster Collection now in the Museum of Comparative Zoölogy, Cambridge, Mass., states as follows: "They are regularly oval in form, all specimens being quite uniform in this respect. The color is a yellowish green of a peculiar shade, quite different from the more decided greenish brown seen in the western species, from which the eggs now in hand differ in being unspotted." I have recently compared the colors of this set of eggs with Ridgway's standard colors and find all to be a deep olive buff. Some of the eggs have irregular-shaped stain marks or patches of a darker shade of buff. One egg has a small spot of drab. Since the eggs have been carefully preserved it is not probable that they have faded or changed color to any marked degree. The colors now are probably the same as they were when Capen described them forty years ago. All other Heath Hen eggs which it has been my privilege to examine are of the same deep olive-buff color. The eggs of the Prairie Hen range from a yellowish glaucous to a dull olive-buff color and are usually sprinkled with brown.

The measurements of the five Heath Hen eggs in the Brewster set are as follows:

1. 43.4 × 32.5 millimeters
2. 43.5 × 32.1 "
3. 43.8 × 32.5 "
4. 43.9 × 32.4 "
5. 46.2 × 32.9 "

The sixth egg of this set, now in the United States National Museum, measures, according to Charles Bendire, 44 × 33 millimeters. The egg in the Brewer Collection collected at Holmes Hole (Vineyard Haven), Massachusetts, measures 44.2 × 32.6 millimeters and the egg at the Boston Society of Natural History collected on Martha's Vineyard in 1916 measures only 40.3 × 30.4, the smallest egg of the species I have examined.

The average size of one hundred Prairie Chicken eggs is 43 × 32.5 millimeters, the largest 46 × 34 millimeters and the smallest 40 × 30 millimeters. The number of eggs to the set of the Prairie Chicken varies from nine to twenty-one. H. A. Kline (1882,

p. 150) reports two sets of the Prairie Chicken which contained twenty-one eggs each. (Such large sets probably represent the eggs of two females.)

According to Alexander Wilson (1832, p. 392) the Heath Hen lays from ten to twelve eggs; James DeKay (1844, p. 205) states the number of eggs varies from eight to twelve and Maynard (1882, p. 350) says there are from eight to fifteen to a set. We cannot be sure, however, whether these statements refer to the eastern or the western Pinnated Grouse as no localities are given. The few nests of the Heath Hen found on Martha's Vineyard indicate that the numbers of eggs per set are small.

The first young of the season make their appearance about the middle of June and broods of various ages have been reported throughout the month of July. The earliest record I have been able to find is of a brood of eight to ten young, about two days old seen near Edgartown, Massachusetts, on June 14, 1913, by Dr. Charles W. Townsend. In an unpublished manuscript, which he kindly submitted to me, Dr. Townsend states, among other things concerning a trip he made to the island, as follows: "We were fortunate in seeing a dozen adult birds and a brood of young. The mother flew off croaking hoarsely, but soon returned on foot to collect her plaintively peeping young." William Brewster in Forest and Stream (1890, p. 188) writes: "On July 19, 1890, I met a blueberry picker who only the day before had started a brood of six young less than half grown. This fact proves that the bird is habitually a late breeder." The following records gleaned from the reservation journal and various reports of the superintendent are of interest. During the season of 1913 nine broods were seen with an average size of four chicks to the brood. On July 15, 1914, Mr. Day found a dead chick which he estimated to be about five days old. In 1915 fourteen broods were reported; the first of the season was a brood of six chicks about five days old, seen on June 19th. Mr. Allan Keniston saw seven broods with an average of five chicks each during the summer of 1918 and in 1919 he reported broods on June 29, July 1, and July 11, the birds of which were able to fly. For the year 1920 the following are noted:—June 20, ten young; June 24, six young; July 4, two small broods, numbers not recorded; July 9, five or six young; July 15, brood of nine and on July 16, a brood of five young. During the summer of 1921 a brood of seven was seen on July 3 and a few days later a brood of eight. On July 31, the latest record of broods, Mr. Keniston saw a brood of six which he states were about two-thirds grown. In 1922 between June 15 and June 30 there were five broods containing four to eight chicks; the dates were not recorded.

Since 1922 the numbers of the Heath Hen have been so greatly reduced that it is now an unusual experience to see a brood of young. Throughout the breeding season of 1923 I traveled many miles by automobile and on foot over the scrub-oak plains in search of Heath Hen and their young. On July 3 Mr. Keniston and I were driving along a little-

used road in the direction of West Tisbury. There was a downpour of rain, conditions under which we least expected to see birds, but at a place about three miles from the reservation we came suddenly upon a female Heath Hen brooding her young in the middle of the road. Her plumage was matted by the heavy rain and she seemed very loath to leave her young. Before Mr. Keniston could bring his car to a stop we almost ran over her. She ran down the road uttering a sharp cry and fluttering her wings as she went. She soon took flight flying farther down the road with a rapid characteristic beat of her wings and then sailed off over the dense foliage of the scrub oaks. There were two young birds about fifteen days old which for an instant were very much bewildered by the sudden appearance of the car. One flew against the radiator, then disappeared from view. The other flew by us very near to the car so that we had an excellent opportunity to gain an impression of its size and manner of flight before it reeled off into the dripping scrub oaks. We attempted to locate the birds but the very heavy downpour handicapped our efforts so that we were not successful. We then remained concealed and quiet for some time but heard no calls from the young and saw nothing more of the adult.

Most of the broods that have been found have been seen by accident, much as in the above instance, by the superintendent while on duty driving along the little-used roadways which traverse the scrub-oak plains. The birds come to the roads to dust but unfortunately it is a dangerous place for the downy young which frequently fall into the deep ruts and are doomed unless the driver removes them to safety.

Food of the Heath Hen.

The Heath Hen in its food habits is similar to other gallinaceous birds such as the Ruffed Grouse, in being very adaptable to the changing food supply throughout the seasons of the year. They are not dependent on any particular item but subsist on that which exists in abundance and which is most readily secured. During the spring months Heath Hen congregate in the open fields and meadows of the farms to feed upon the tender shoots of grasses, sorrel and other plants, but when these become hardened and less palatable with the approach of summer the birds change their diet to fruits and insects. In the fall, seeds, berries and insects such as grasshoppers are freely eaten and in the winter months acorns, seeds and certain berries found in abundance throughout the present range of the Heath Hen provide the birds with a livelihood. A comparatively small amount of snow falls on Martha's Vineyard, hence it is an exceptional winter when these birds are unable to secure sufficient food from native plants. Even at times when the ground is covered with snow the scrub oaks hold out an exhaustless supply of food.

It is difficult to secure detailed information concerning the food of the Heath Hen

because no systematic study was made of this problem at the time the birds were abundant and now that the birds are so greatly reduced we must depend on the meager notes contained in the writings of the earlier ornithologists, records made in connection with museum specimens and from field notes secured during the several visits to Martha's Vineyard.

Following is a brief discussion of some of the principal foods eaten by the Heath Hen.

Vegetable Food.

Bayberry or Waxberry, *Myrica carolinensis* (Mill.).—The Bayberry (Pl. 47, fig. 26) flourishes on the sandy sterile soil in many places especially along the southern shores of Martha's Vineyard and it is well represented in the region inhabited by the Heath Hen. In certain situations it grows to a height of more than six feet, but most of the shrubs are less than two feet high and in the windswept areas of the island are more or less recumbent, a condition which makes the berries easily accessible to the Heath Hen.

The crops of three Heath Hen collected by C. E. Hoyle, on January 10, 1891, and two on December 28, 1895, contained bayberries. Mr. Allan Keniston reported finding the remains of a Heath Hen which was being eaten by a Snowy Owl. The crop of this bird was gorged with bayberries, no other food being present. Mr. William Day found that captive Heath Hen which he had at the reservation in 1915 fed very freely on bayberries. During the winter of 1923–24 a flock of about fifteen Heath Hen frequented the plains bordering the coves along the northeastern shore of Great Tisbury Pond, a region where bayberries abound. Since the birds were frequently flushed from the bayberry thickets it is reasonable to infer that they were seeking the berries for food.

Cranberry.—John Latham in his General History of Birds (1823, vol. 8, p. 237) includes cranberries, *Vaccinium oxycoccos* and *Vaccinium myrtillus*, in his list of foods eaten by the Heath Hen. *V. myrtillus*, commonly known as whortleberry, hurtleberry, "hurts" or bilberry, is an Old-World form found in the mountainous regions of North America. *Vaccinium oxycoccos* is the small cranberry also of the Old World and in this country is found from Newfoundland to British Columbia south to Michigan and in the mountains to North Carolina. It is doubtful if these two species of cranberry were ever extensively used by the Heath Hen as an article of food. It is possible that these plants were confused with some other species, such as bearberries which were common in situations where the Heath Hen were found. Several writers who followed Latham copied his list of foods including the two species of cranberry hence these lists do not necessarily substantiate Latham's record.

The crops and stomachs of ten birds collected by C. E. Hoyle were reported by him as containing cranberries but since no specific name of cranberry is given it leaves one in

doubt as to what is meant. Seven of the ten birds were collected during the month of October, two in November and one in December. The Heath Hen are seldom seen in the low, wet, boggy ground of the island such as is prevalent where the American cranberry, *Vaccinium macrocarpon* Ait., grows. It is doubtful if this species is meant and probably Hoyle's so-called cranberries are some other species of berry such as the bearberry.

Bearberry, *Arctostaphylos uva-ursi* (Linné) Spring.—Several specimens of bearberries collected on the reservation were identified by the Gray Herbarium, Cambridge, Massachusetts, as the variety *coattilis* (Fernald and Macbr.).

The bearberry is a trailing, spreading plant which is abundant among the scrub oaks in all parts of the area inhabited by the Heath Hen. In autumn these plants are full of red berries ranging from one fourth to nearly one half of an inch in diameter, and to the layman closely resemble cranberries. Indeed these berries are called mountain cranberries by the natives of Martha's Vineyard but as far as I have been able to ascertain no specimens of the true mountain cranberry have ever been found on the island. The mountain cranberry is a northern plant and along the New England coast does not occur south of Cape Ann, Massachusetts. A Heath Hen collected by C. E. Hoyle on December 28, 1892, and now in the collection of the American Museum of Natural History, was recorded as having its crop filled with mountain cranberries. This record is undoubtedly a clear case of bearberry and I am inclined to believe that the ten records of cranberries mentioned above are also bearberries which Hoyle believed to be the mountain cranberry. Further evidence which bears out this supposition is a female specimen collected by Mr. Outram Bangs in December, 1895 (M. C. Z., No. 246,064) about the same time that Hoyle secured his birds; this female is recorded by Mr. Bangs as having bearberries in its crop.

I have frequently started Heath Hen from bearberry patches and examination of the plants gave evidence that the fruits were being freely eaten. George H. Van Note (Bird-Lore, 1903, vol. 5, p. 50) in a letter written to Dr. Frank M. Chapman speaks of the food of the Heath Hen when these birds existed on the New Jersey plains as follows: "All through the plains there is a little vine that bears red berries about the size of a cranberry and keeps sound and good the year round. It is called the grouse berry. This berry the grouse lived on in winter." Van Note's so-called grouse berry may also be the bearberry which is a common plant on the plains of New Jersey. The bearberry apparently was and is now freely eaten by the Heath Hen but the true cranberry probably never formed an important element of its food.

Barberry, *Berberis vulgaris* (Linné).—Audubon in his Birds of North America (1842, vol. 5, p. 93) quoting from a letter written by David Eckley, Esq., of Boston states: "The

barberry which abounds in many parts of Martha's Vineyard is the chief food of the Grouse [Heath Hen]." The barberry is included in the lists of food eaten by the Heath Hen by other earlier writers but I obtained no evidence indicating that the Heath Hen at the present time depends on barberries for a source of food.

Wild Rose Berries, Apples or Hips.—One specimen of the Heath Hen collected March 7, 1896, had eaten rose berries together with leaves and buds. Rose berries constitute one of the important foods of the Ruffed Grouse and of the Prairie Hen (Judd, 1905, p. 15) and it is reasonable to suppose that the Heath Hen also feeds upon them whenever this food is abundant within the feeding range of the birds. Audubon listed rose buds as one of the foods of the Heath Hen.

Strawberry.—Thomas Nuttall in his Manual of Ornithology (1832, p. 662) states that wild fruits such as strawberries which abound in the thickets are one of the inducements of the Heath Hen. The birds feed freely on the wild strawberries which grow abundantly in some of the open fields of the reservation. The birds are also fond of the cultivated varieties of strawberries as is evidenced by the frequent visits they make to gardens where the berries are grown. On some farms, in the past, the visits of the Heath Hen were so frequent and their depredations so great that the owners complained of their loss. The birds were frequent visitors to the farm of Charles Seafoot in West Tisbury where they fed freely on the strawberries growing near his house. Mr. Seafoot stated that he never discouraged their visits. Mr. William Day in his report for 1913 writes that the Heath Hen on the reservation are very fond of strawberries.

Partridge-berry, *Mitchella repens* (Linné).—The partridge-berry (checkerberry, boxberry, winter red clover, squaw-berry, twin-berry) is a trailing evergreen herb which has bright scarlet berries that remain in an edible condition throughout the winter. It was so generally eaten by the Heath Hen that the name Heath Hen plum was used as a synonym for this plant by the earlier ornithologists. Not only the berries but also the leaves of the partridge-berry are freely eaten by the birds during the late fall and the winter months.

Blueberry.—Three species occur: *Vaccinium vacillans* (Kalm), late low blueberry, blue huckleberry; *Vaccinium pennsylvanicum* (Lam.), low sweet, dwarf, sugar or low-bush blueberry; and *Gaylussacia baccata* (Wang.) Koch, black huckleberry.

Blueberries grow in great luxuriance on the sandy plains of Martha's Vineyard. In the summer of 1923 when making frequent trips over the plains I sometimes flushed the Heath Hen from patches of blueberries which were laden with an abundance of delicious fruit. There was evidence that the fruit was being eaten by the birds.

On August 24, 1913, Mr. William Day, then superintendent of the reservation, saw a flock of fifty-one Heath Hen feeding on blueberries. Mr. Day also reports that captive

birds at the reservation ate very freely of blueberries provided for them. He does not state the kind he used but it was probably one of the species of *Vaccinium*.

None of the museum specimens was recorded as having blueberries in the crop and stomach contents, as no birds in which food was noted were collected at the season of the year when the berries were ripe. The older authors include in their lists the name whortleberry which seems to be a rather loosely used term and may include species of *Vaccinium* known to us as blueberries.

Acorns.—The acorns of the scrub oaks (Pl. 47, fig. 27) have been called "the bread" of the Heath Hen. No natural food is more abundant on Martha's Vineyard and none more dependable during the winter months. Even snow does not deprive the birds of this food which is never completely covered as are the berries and leaves of trailing plants. Although many of the acorns drop to the ground when mature, others if not disturbed remain in place until the following spring. The scrub-oak acorns are small and when eaten are swallowed whole by the birds. Acorns were found in the crops and stomachs of nine birds collected by C. E. Hoyle and others. One of the birds was collected in January, one in February, one in October and the other six in December, indicating that acorns are chiefly a winter food. William Brewster (1885, p. 80) states that the Heath Hen feeds largely on acorns. John Latham (1783, vol. 4, p. 740) writes that the winter food is chiefly acorns and buds and Alexander Wilson agrees that acorns of the scrub oaks provide one of the strongest reasons for the preference shown for the plains. Acorns appear on practically every published list of the food of the Heath Hen and without question constitute one of the most important elements of the food of these birds during the winter.

The black scrub oak, *Quercus ilicifolia* Wang., is the commonest form of the scrub oak on the plains of Martha's Vineyard but several specimens sent to the Gray Herbarium proved to be *Quercus prinoides* Willd. The white oak, *Quercus alba* (Linné), and the black oak, *Quercus velutina* Lam., are also common in certain parts of the island and a few are interspersed here and there throughout the plains. Since the Heath Hen frequently alight in the taller oaks it is probable that the acorns of these trees are also eaten.

Leaves.—Leaves were found among the food of ten museum specimens but with very few exceptions the species of plants are not indicated. Observations made from blinds on the feeding grounds where the birds congregate in spring showed that practically all of their food at that season of the year consisted of the new tender shoots and leaves of herbaceous plants, clover and grasses. The birds which I observed showed a distinct preference for the leaves of sheep sorrel, *Rumex acetosella* (Linné), over other plants such as clover and grasses which were equally abundant on the field in the vicinity of the blind. The distribution of the birds on the field usually corresponded at least roughly, to the

distribution of this plant. Sheep sorrel thrives in acid soil and no special cultivation is needed to produce it. One male specimen of the Heath Hen trapped on April 5, 1924, had its crop gorged with the leaves of sorrel. There were in this specimen 1846 leaves and parts weighing 32.2 grams. The only other food in the crop was 38 grains of corn which were secured from the bait used in the trap. A bird trapped on April 15, 1924, by Mr. Keniston had an empty crop but the stomach was full of sorrel leaves with a few grains of corn. Another bird trapped May 20, 1924, had its crop completely filled with 38.6 grams of sorrel seeds. These cases illustrate how extensively a certain plant may be used by the Heath Hen in preference to all others. In the above cases there was scarcely a vestige of clover, grass or other plants which were growing in abundance all about the sorrel. Not only the leaves but also the seeds of the sorrel are used. This decided preference for sorrel is by no means universal but the birds may sometimes feed on clover as is well known by those who have watched certain individuals in the clover fields. I have also seen Heath Hen nip the tender leaves of rabbit-foot clover, *Trifolium arvense* (Linné), yellow clover, *Trifolium agrarium*, ox-eye daisy, *Chrysanthemum leucanthemum* (Linné), alfalfa, *Medicago sativa*, and rib-grass, *Plantago lanceolata*. I am unable to state to what extent these plants are used as food but my experience in watching the birds at close range for many weeks indicates that none of them is used as much as the sheep sorrel.

A specimen collected by C. E. Hoyle on December 28, 1892, had its crop filled with sorrel indicating that this plant may be used during the winter when the ground is not covered with snow. Hoyle (1901, vol. 1, p. 200) mentions sorrel as one of the principal foods of the Heath Hen. He also states that the birds are fond of the leaves of cranberry (probably bearberry which as before noted is common throughout the plains inhabited by the Heath Hen).

Buds.—Buds were found in the records of five museum specimens. With the exception of one bird collected December 28, 1895, where pine buds are designated, the kinds of buds are not mentioned. Latham stated that the winter food of the birds is chiefly acorns and buds. Audubon includes rose, pine and alder buds in his list of the foods and Alexander Wilson emphasizes the importance of pine buds as a food of the Heath Hen. Dr. George W. Field (1913, p. 353) states that the Heath Hen "eats considerable quantities of the terminal buds of the pitch pine and its needles, cutting them off with a scissors-like action of the bill in the same manner as does the Spruce Grouse."

Cultivated Crops.—Since the reservation was established on Martha's Vineyard various crops have been planted to provide food in addition to that supplied by the native plants growing within the range of the Heath Hen. Corn, buckwheat, millet, clover and sunflowers are among the principal crops which have been raised and in the past the birds

have eaten very freely of this food which was left in the fields throughout the winter. This food, however, especially the corn, has proved to be such an attraction for rats and Crows that it seemed expedient to discontinue the extensive farming operations and instead purchase food to be distributed in small amounts from time to time as might be needed by the birds. In the past it has been noted that the Heath Hen visit certain gardens to feed upon the leaves of beets and carrots and the tender shoots and blossoms of peas and beans. Since this food can be grown at small expense and as it will not be attractive to Crows and rats it was suggested that a limited amount of such vegetables be planted on the reservation. Mr. William C. Adams has accordingly this past spring (1926) caused several strips of vegetables to be planted on the reservation in places where they are most likely to be found by the birds. The ground has been heavily fertilized with manure which in addition to producing more vigorous growth will provide conditions under which earthworms and insects will be produced in greater numbers. Mr. E. H. Forbush has pointed out the importance of animal food for the birds during the spring and summer. It is especially necessary to the females who need it to provide elements for the production of eggs and to give them the needed vigor for the ordeal of incubation and rearing of young. It is hoped that the planting of vegetables and the continuation of the practice of providing food as indicated above will be of considerable assistance in sustaining the stock.

Animal Food.

Insects.—It is probable that more insects are eaten by the Heath Hen than our meager records would seem to indicate, as a very small number of birds were collected during months when insect food is abundant. Some of the earlier authors who lived at a time when the birds were abundant include insects as an important element of the food.

The Heath Hen like other gallinaceous birds is apparently very adaptable in its eating habits and chooses that which is most abundant and most easily secured. At times when some insect becomes unusually abundant these Grouse are quick to adapt themselves to the situation and may feed almost exclusively on the particular insect which has temporarily overcome its usual checks in Nature. At one time when there were a large number of army worms devastating crops and vegetation on Martha's Vineyard, E. H. Forbush (1914, p. 401) saw Heath Hen eating these worms, yet in normal times armyworm larvae constitute a negligible part of the food.

In the Middle West the Prairie Chicken, whose feeding habits are probably very similar to those of the Heath Hen, has been praised for its destruction of grasshoppers during times of the so-called grasshopper plagues. Robert Bell (1875) writing at a time when the Prairie Chickens were abundant states: "From the time the young grasshoppers come out in the Spring, till the last old ones disappear in the Fall, these insects contribute

the favorite food of the chickens. When they are abundant their crops are stuffed full of them." Bell at that time attributed the occurrences of grasshopper plagues to the wholesale exportation of Prairie Chickens. In an article, "Grouse versus Grasshoppers" he states that 20,000,000 Prairie Chickens and Quail were shipped from Kansas and he estimated that if the birds were allowed to live they would have consumed 60,000,000 gallons of grasshoppers. While the above figures may be an exaggeration they do emphasize the fact that grasshoppers form an important part of the food of the Prairie Chicken when these insects are abundant. I have not been able to find any food records of the Heath Hen for the months from June to September, but the crops of four museum specimens collected in October, one in November and two in December contained grasshoppers. The latest date on which grasshoppers were found to be eaten by the Heath Hen was the record of a female specimen collected on Martha's Vineyard, December 24–25, 1890, and now in the New York State Museum (Marshall, 1892). The Prairie Hen has been found to be a destroyer of the potato beetle (McAtee, Bull. U. S. Biol. Surv., No. 32, p. 47) and Dr. Sylvester D. Judd has emphasized the importance of the Heath Hen as a destroyer of insects (Judd, S. D., Year Book U. S. Dept. Agr., 1898, p. 231; Bull. U. S. Biol. Surv., No. 28, p. 14, 1905).

Food of the Young.

We have very little data concerning the food of the young of the Heath Hen but judging from what we know of the food of the young Prairie Chickens (Bendire, 1897; Judd, S. D., Bull. U. S. Biol. Surv., No. 24, p. 18, 1905;) it is reasonable to suppose that in the early stages of development the food consists largely of insects. This supposition is borne out by the crop contents of a five-day-old chick found by Mr. William Day on July 15, 1914. Dr. David L. Belding who made an examination of the crop and stomach contents at that time counted over 80 insects representing over ten species. Dr. Belding did not determine the species of insects but placed them in groups as follows:

1. Caterpillars of Geometridae (about 65)
2. Heteroptera (assassin bug of long-horn division)
3. Homoptera (one green, two brown bugs)
4. Land bug (one of the Heteroptera of which there were two specimens, one large, one small)
5. Dipterous larvae; maggot (two black ones and one in the pupal stage)
6. Two species of Lepidoptera larvae, in all five specimens
7. Small tree-hopper
8. Grasshopper (Acrididae)
9. Caddis-fly

Preserved Specimens of the Heath Hen.

The following list of preserved specimens of the Heath Hen has been prepared primarily for the use of museums and ornithologists who will find it a convenience in readily

locating material for study. The 208 specimens comprising the list were collected on Martha's Vineyard with the exception of one bird, now in the collection of the Boston Society of Natural History, which was taken on Nashawena Island near Martha's Vineyard. An effort has been made to locate specimens taken in other parts of the former range of the Heath Hen but nothing has been found save a sternum in the collection of the United States National Museum which, according to Dr. Alexander Wetmore, is from a bird collected on Long Island, New York.

There are statements in the earlier ornithological writings indicating that Heath Hen collected in Virginia, Long Island, and various places of New England were preserved. But these specimens as far as I can determine no longer exist. Most of them were probably mounted birds which after a generation were relegated to attics or neglected cabinets where moths and *Dermestes* completed their work of destruction.

Collection.	*Mounted Specimens.*			*Skins.*			*Total.*
	Male	Female	Sex?	Male	Female	Sex?	
Frederic H. Kennard, Newton Center, Massachusetts	1	1		14	15		31
Museum of Comparative Zoölogy, Cambridge, Massachusetts	1	1		13	12	(3 chicks)	30
American Museum of Natural History, New York City	1	2	(1 chick)	4	3		
Coll. L. C. Sanford	1			6	3		
Coll. Dr. J. Dwight				2	2	(1 im.)	26
Thayer Museum, Lancaster, Massachusetts	4	4	(6 chicks)	3	6	2	25
Boston Society of Natural History, Boston, Massachusetts	3	1	2	5	3	(1 chick)	15
Academy of Natural Sciences, Philadelphia, Pennsylvania	1	1		2	2	5	11
Arthur C. Bent, Taunton, Massachusetts				2	3		5
Field Museum, Chicago, Illinois	1	1		1			
Coll. H. B. Conover					1	1	5
U. S. National Museum, Washington, D. C.	1	1				3 im. alc.	5
Zoölogical Museum Tring, Herts, England				2	2		4
U. S. Biological Survey, Washington, D. C.				3	1		4
Carnegie Museum, Pittsburgh, Pennsylvania				1		2	3
University of Iowa, Iowa City, Iowa	1	1			1		3

Collection.	*Mounted Specimens.*			*Skins.*			*Total.*
	Male	Female	Sex?	Male	Female	Sex?	
University of Michigan, Ann Arbor, Michigan				1	1		2
British Museum, London, England				1	1		2
Brooklyn Museum, Brooklyn, New York	1	1					2
E. E. Murphy, New York City				1	1		2
Allan Brooks, Okanagan Landing, British Columbia				2			2
J. A. Webber, Leonia, New Jersey						2	2
J. Eugene Law, Altadena, California				1	1		2
Cape Ann Association, Gloucester, Massachusetts	1	1					2
Dr. George W. Field, Sharon, Massachusetts	2						2
New York State Museum, Albany, New York	1	1					2
Children's Museum, Jamaica Plain, Massachusetts	1						1
Peabody Museum, Salem, Massachusetts		1 im.					1
Donald R. Dickey, Pasadena, California				1			1
Natural History Museum, Pittsfield, Massachusetts	1						1
Colorado Museum, Denver, Colorado				1			1
Walter Koeltz, Ann Arbor, Michigan					1		1
Museum of Vertebrate Zoölogy, Berkeley, California				1			1
L. A. Fuertes, Ithaca, New York				1			1
Los Angeles Museum, Willett Coll., Los Angeles, California					1		1
Academy of Sciences, Leningrad, U. S. S. R.				1			1
Martha's Vineyard Island, J. Howland		1					1
W. Dugan	1						1
O. S. Mayhew		1					1

Collection.	*Mounted Specimens.*			*Skins.*			*Total.*
	Male	Female	Sex?	Male	Female	Sex?	
Martha's Vineyard Island, (*Cont.*)							
H. Norton		1					1
Howes Norris	1						1
Allan Keniston	1						1
Heath Hen Investigation Specimens				3	(2 males in alc.)		5
Totals	25	20	9	74	60	20	208

Of the 208 specimens 99 are males, 80 are females and in 29 cases the sex was unknown because of immaturity or for other reasons it was not reported.

Nomenclature.

Tympanuchus cupido cupido (Linné).

Urogallus minor fuscus in cervice plumis alas imitantibus, Klein, Av. 117. vii., Catesby, vol. 2, App., p. 1, pl. (1743)

Gelinotte huppée d'Amérique, Sonnini, Buffon, vol. 6, p. 74

Attagen Americana, Brisson, Ornith., vol. 1, p. 212; Id., 8vo, vol. 1, p. 59

Tetrao cupido
- Linné, Syst. Nat., ed. 12, vol. 1, p. 274 (1766)
- Gmelin, Syst. Nat., ed. 13, vol. 1, pt. 2, p. 751 (1788)
- Latham, Index Ornith., vol. 2, p. 638 (1790)
- Temminck, Pigeons et Gall., vol. 3, pp. 161, 703 (1815)
- Vieillot, Gal. Ois., vol. 2, p. 55, pl. 219 (1825)
- Nuttall, Man. Ornith., vol. 1, p. 662 (1832)

Pinnated Grouse
- Latham, Gen. Synopsis, vol. 2, pt. 2, p. 740 (1783)
- Pennant, Arctic Zoöl., vol. 2, p. 305 (1785)
- Latham, Gen. Hist. Birds, vol. 8, p. 237 (1823)

Bonasa cupido Stephens, in Shaw's Gen. Zoöl., vol. 11, p. 299 (1819)

(*Cupidonia americana*) (A composite including Heath Hen)
- Reichenbach, Avium Syst. Nat., p. xxix (1850)
- Bonaparte, Comptes Rendus, vol. 45, p. 428 (1857)

Cupidonia cupido
- Baird, Birds of N. Am., p. 628 (1860)
- Maynard, Birds E. Mass., p. 138 (1870)
- Coues, Key N. Am. Birds, p. 583 (1884)
- Brewster, Auk, vol. 2, p. 82 (1885)

Cupidonia cupido var. *cupido*
- Baird, Brewer and Ridgway, N. Am. Birds, vol. 3, p. 440 (1874)

Cupidonia cupido brewsteri Coues, Key N. Am. Birds, App., p. 884 (1887)

Tympanuchus cupido
- Ridgway, Proc. U. S. Nat. Mus., vol. 8, p. 355 (1885)
- A. O. U. Check-list, p. 175 (1886)
- Ridgway, Man. N. Am. Birds, p. 203 (1887)
- A. O. U. Check-List, p. 143 (1910)

William Brewster (1885, p. 80) called attention to differences between the Pinnated Grouse (Heath Hen) of Martha's Vineyard and the western Pinnated Grouse or Prairie Hen. He named the western form as the new species because *Tetrao cupido* of Linné was the eastern form from the fact that its habitat is given as Virginia. The differences between these two birds which Brewster cited as reasons for the establishment of two distinct species are: "The Heath Hen are smaller with relatively as well as actually shorter tarsi; the feathers of the neck tufts narrower and acutely instead of obtusely lance-pointed; general redder or rustier coloring above and much less white or whitish below." He also stated that the neck tufts of the Heath Hen have only from four to five instead of seven to ten rigid feathers.

Many of our leading American ornithologists now agree that the differences between these two birds are not sufficient to warrant the recognition of two species but consider the Heath Hen and the Prairie Hen as geographical representatives of a single species. It is possible that originally there was an almost uninterrupted distribution from New England through Pennsylvania and Kentucky, to the States of the Middle West. The fact that today the Martha's Vineyard birds are separated from the western form by nearly one thousand miles, through man's intervention, does not in the least alter the situation. We have a parallel in certain island forms of birds which today no longer have intermediate representatives.

Through the courtesy of the Museum of Comparative Zoölogy and other museums I have been able to examine and compare a large series of Heath Hen with a correspondingly large series of Prairie Hens including Brewster's co-types. I have been able to find a large number of intermediates and in several instances it was difficult to tell which was a Heath Hen or a Prairie Hen without recourse to the label. The best characters which serve to separate the Heath Hen from the Prairie Hen are the *usually* fewer ruff feathers which are generally shorter and more pointed, the more heavily barred under parts and axillaries and the darker and slightly more rufescent upper surface. (The darker and wider barring is accentuated in birds recently taken at the Island.) These characters are by no means constant and hold good only on the average. This means that intergradation by individual variation takes place and, as Dr. Harry C. Oberholser points out, the two forms must be regarded as subspecifically related. It is therefore proposed that the Eastern Pinnated Grouse or Heath Hen be designated by the trinomial *Tympanuchus cupido cupido* (Linné), the Western Pinnated Grouse or Prairie Hen by *Tympanuchus cupido americanus* Ridgway, and the closely related form, Attwater's Pinnated Grouse, distributed along the coastal region of Louisiana and Texas, as *Tympanuchus cupido attwateri* Bendire (1893, p. 425). The Lesser Prairie Hen, *Tympanuchus pallidicinctus* Ridgway (1874 p. 199), is smaller and lighter colored than the above forms of *cupido*

and has bicolored barring on lower and upper parts. I have been unable to find any striking intermediates in the material examined and the fact that the ranges overlap is significant. Therefore *pallidicinctes* should be left a distinct species rather than a form or subspecies of *Tympanuchus cupido*.

The name *pinnata* was applied to the Prairie Hen by William Brewster (1885, p. 80). The spelling was changed to *pinnatus*, according to the code, when the genus was changed from *Cupidonia* to *Tympanuchus* (Ridgway, 1885, p. 355). The name *pinnatus* was changed to *americanus* by Robert Ridgway (1886, p. 132) who stated his case as follows: "In giving a new name to the western bird, Mr. Brewster has unfortunately overlooked a supposed synonym of *T. cupido*, which applies exclusively to the western species. . . . The supposed synonym in question is that of *Cupidonia americana* Reich. Syst. Av. 1850, p. xxix, based on figures 1896–98 of his 'Icones Avium' (Vollständ. Naturg. Huhnerv. Aves Gallinaceae). The two smaller of these figures unquestionably represent the western Prairie Hen; the other, and principal figure, is a reduced copy from Wilson's (American Ornithology, pl. 27, fig. 1) which the author tells us is 'A figure of the male . . . . as large as life, drawn with great care from the most perfect of several elegant specimens shot in the Barrens of Kentucky. It is thus plain that the western Pinnated Grouse, or Prairie Hen, must be called *Tympanuchus americanus* (Reich.)." Though we are accepting the name *americanus* it is well to emphasize the fact that not all ornithologists are inclined to agree that Ridgway was justified in making this change and hence a discussion of this matter is relevant. After a careful study of Reichenbach's plate I am convinced that the two smaller and original figures may be referred to either species. It is also doubtful if the large figure, evidently copied from Wilson represents the Prairie Hen, as it fits either bird equally well. No one can be positive what subspecies was represented on the "Barrens" of Kentucky though it was probably more like the eastern form. The environment provided by the "Barrens" is much more like the scrub-oak plains chosen by the Heath Hen and not at all like the grassy plains on which the typical Prairie Hen lives. Furthermore in Reichenbach's text (Avium systema naturale, 1850, p. xxix) he refers only to Brisson (1760, Ornithologie, vol. 1, p. 212) and Brisson refers to Catesby's figure (1743, Natural History of Carolina and Bahama Islands, vol. 2, append., p. 1) which all ornithologists agree represents the eastern form. If Reichenbach's name is synonymous with *Tympanuchus cupido cupido* then Brewster's name *pinnatus* should stand. There is, however, an element of doubt and the name *americanus* as applied by Reichenbach is probably a composite. Ridgway as the first reviser has the privilege of fixing on either of the two elements of the composite since Brewster did not mention the name *americanus*. The rules of nomenclature provide that in such cases the first reviser's dictum is to be followed and that a name in current use should not be

displaced by another unless absolute identification is possible. It might be argued that since Ridgway did not recognize *americanus* as a composite he forfeited his right to be considered the first reviser, but this would be a very narrow technical construction of the case. My feeling is that it is more in accord with the spirit of current nomenclatural usage to continue the use of the name *americanus* for the Western Prairie Hen.

Description of Adult Heath Hen, *Tympanuchus cupido cupido*.

Male.

The following description is based on three male birds trapped on Martha's Vineyard Island, April 5, April 15 and May 20, 1924, respectively.

Upper parts.—Feathers of the middle crown black, narrowly tipped with dusky white. Crest feathers with concealed cinnamon-rufous patches; loral patch white; sides of crown, nape and hind neck variegated with black, cinnamon and white, the last predominating. Feathers of the lower hind neck barred with cinnamon and blackish brown and broadly tipped with dusky white or pale gray; back, rump and upper tail-coverts barred with blackish brown and various tints and shades of cinnamon; the darker bands with cinnamon patches finely spotted with black, many of the feathers tipped with tilleul buff finely spotted with blackish brown. The wing-coverts with conspicuous tips and bands of dusky white; primaries fuscous, the narrow outer vane of the outer six or seven primaries banded with tilleul buff. The lower hind neck presents a distinctly banded appearance but this banding is lost in the remainder of the upper parts where the plumage presents a variegated or mottled appearance.

Tail: rectrices fuscous to fuscous black narrowly tipped with dusky white; middle tail-feathers with irregular markings of light vinaceous cinnamon.

Pinnae: five to six feathers, 50 to 75 mm. in length, black, and four to six feathers black, streaked with white and cinnamon. One specimen has seven entirely black feathers.

Under parts.—Chin and throat dusky white; a band under and extending from the bill to the auricular region, chestnut brown; upper fore neck spotted and streaked with white, cinnamon and brown; lower fore neck natal brown narrowly tipped with dusky white; breast and belly barred with fuscous and pale smoke gray. The fuscous is darker on the breast and the color of the anterior feathers blends into the Natal brown of the fore neck. Flanks similar to the breast but with more cinnamon; middle of the belly white. Under tail-coverts white with irregular markings of cinnamon and fuscous. In the field the under tail-coverts give the appearance of being pure white when the tail is erected during the "tooting" performance. Tarsus feathered on the front and sides, the feathers extending posteriorly and concealing the naked part. In most specimens these

feathers are of a plain drab color and in some there is a distinct crossbarring of slightly darker color.

Color determinations of parts which quickly change color after death were made at Martha's Vineyard from living birds or immediately after they were killed. These determinations represent the average color condition of several specimens. The colors were as in the above description determined with the aid of Ridgway's standards (1912).

Iris: Verona brown 13″k.

Mandibles: light olive-gray 23‴″d to dark olive-gray 23‴″i. The tip is of a much lighter color than the base.

Toes: ochraceous-buff 15′b to ochraceous-orange 15′.

Superciliary comb: orange 15a; very brilliant during the breeding season when the birds were studied.

Vocal sac: ochraceous orange 15′ when deflated but approaching more nearly a pure orange when inflated. The edges of the sac have a narrow margin of scarlet red which can easily be seen when observing the birds at close range. The vocal sac is very vascular and the reddish color seems to be due to the presence of blood at the margin of the sac rather than to a pigment.

Female.

Similar to the male but slightly smaller. Pinnae much shorter and without the prominent stiff feathers. Vocal sac not developed. Superciliary comb lacking. Tail-feathers distinctly barred with vinaceous buff, the barrings most conspicuous on outer vanes of feathers where there are five to six bars to each vane. I can find no consistent striking difference in the general coloration between males and females.

Comparison with other Races.

The under parts of a series of *Tympanuchus cupido cupido* appear very much darker on the average than the under parts of a series of *T. cupido americanus*. The dark bars of the former are fuscous to olive brown while those of the latter are buffy brown. In addition to this difference in color, the bars of *cupido* are relatively wider and the white bars and tips are less prominent. In *attwateri* the dark bars are much paler and have a uniform drab color. The difference in the coloration of the upper parts in these three subspecies is less pronounced. In *cupido* the upper parts are tawny and shades of cinnamon rufous, whereas in the Prairie Chicken (*americanus*) cinnamon and tawny olive predominate. These colors are much subdued in *attwateri*. In the latter the head and neck including pinnae are suffused with cinnamon rufous. The most striking difference between *attwateri* and the other two forms of *Tympanuchus cupido* is the scant feathering of the tarsus which does not extend to the base of the toes. The feathers of

the pinnae or neck-wings differ somewhat in shape, those of the Heath Hen in extreme cases being more acutely pointed than those of the Prairie Hen. It is difficult to determine the number of stiff feathers in the pinnae as there is a uniform series from the longest down to the ordinary feathers of the neck region. In comparing a series of about ten skins of each of the three forms I found an average of about eleven feathers in the pinnae of the Heath Hen, fifteen in the Prairie Hen and eighteen in Attwater's Prairie Hen. While these proportions are by no means constant, it requires only a superficial examination to note the increasing number of feathers in the pinnae as we go through a series from *cupido* through *americanus* to *attwateri*.

Measurements and Weights of Heath Hen.

Since it is a rare opportunity to secure Heath Hen in the flesh a large number of measurements (28) were made of each of seven male Heath Hen secured at the reservation on Martha's Vineyard. Many of the measurements given are of more value to the morphologist than to the systematic ornithologist but are of sufficient general interest to include in this paper. The method of taking certain of the unusual measurements is given below.

Body-wing is the distance from the thorax to the tip of the longest primary of the outstretched wing; *pinna* is the length of the longest feathers of the neck-wings; *pinnae extent* is the distance from tip to tip of the outstretched pinnae; *gape* is the distance from angle of mouth to tip of bill; *width of mouth* is the distance from the angle of the mandibles of one side to the angle of the other side; *eye-bill* is the distance from the anterior angle of the eye to the tip of the bill; *tarsus-toe* is the distance from the heel to the tip of the nail of the third toe; *tarsus* equals the above measurement minus the length of the third toe; *body-toe* is the distance from the abdomen to the tip of the third toe-nail; *web between toes* is the distance from the angle of the toes to edge of the web.

Measurements of Adult Male Heath Hen.

Number	1.	2.	3.	4.	5.	6.	7.
Date	April 24, 1923.	May 26, 1923	August 22, 1923.	June 23, 1924.	April 5, 1924.	April 15, 1924	May 20, 1924.
Weight:							
Ounces	28.88	28.45	26.15	25.25	33.50	32.02	30.97
Grams	818.74	806.55	741.35	715.83	949.72	907.76	877.99
Temperature F.	....	....	108.9°	109.1°	108.6°	108.5°	109.2
Length	446	442	436	459	478	462	455
Bill	22	22	22	22	23	25	24
Tail	126	124	134	118	142	116	122
Extent	731	711	714	716	736	727	721
Wing	227	226	225	222	232	220	218
Body-wing	323	310	317	308	335	318	310
Fifth Primary	155	159	160	158	176	163	161

Measurements of Adult Male Heath Hen — continued.

Number	1.	2.	3.	4.	5.	6.	7.
Date	April 24, 1923.	May 26, 1923.	August 22, 1923.	June 23, 1923.	April 5, 1924.	April 15, 1924.	May 20, 1924.
Fifth Secondary	110	109	110	109	109	111	105
Pinna	75	76	80	80	79	79	75
Pinnae extent	182	179	194	192	203	185	177
Gape	31	30	28	32	29	29	26
Width of mouth	15	16	17	18	19	17	15
Eye-bill	34	36	35	34	36	34	38
Eye-diam.	10	9	10	11	11	9	10
Eye-comb:							
Length	23	26	24	24	26	22	22
Width	8	8	8	8	7	6	7
Tarsus-toe	104	104	109	107	109	103	111
Tarsus	50	52	58	55	56	52	58
Body-toe	171	182	200	194	198	211	215
Toe One	19	19	19	21	18	20	18
Nail	8	8	8	8.5	8	8	8
Toe Two	36	36	35	39	41	41	38
Nail	10	10	11	9.5	11	11	10
Toe Three	54	52	51	52	53	51	53
Nail	11	11	13	13	13	12	12
Toe Four	34	39	37	36	39	39	38
Nail	9	9	10	broken	10	9	9
Web between toes 2 and 3	10	10	9	10	11	9	9
Web between toes 3 and 4	12	12	10	13	12	11	12

The following measurements of length and extent and weight were determined from freshly killed birds and recorded on the specimen labels by C. E. Hoyle. Since these determinations cannot be made accurately from dried skins it is important to record them. Hoyle made his measurements in inches and his weights in ounces. For the convenience of the reader the equivalents in millimeters and grams respectively are given.

Measurements and weights noted by C. E. Hoyle.

		Length.					
		Average		Maximum		Minimum	
	Number	inches	mm.	inches	mm.	inches	mm.
Males	19	17.71	449	18.50	470	17.00	432
Females	26	17.07	433	18.75	476	16.00	406
				Extent.			
Males	19	28.54	725	29.75	756	27.50	698
Females	26	27.58	701	30.25	768	26.50	673
				Weight.			
		ounces	grams	ounces	grams	ounces	grams
Males	14	34.10	967	38.00	1077	30.00	850
Females	7	33.25	943	32.00	907	25.50	723

The following measurements were made of skins in the collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts. The measurement of length is not always satisfactory in measuring individual skins but in a series it serves well for purposes of comparison. The length of the bill in all the following measurements was taken from the base of the frontal bone to the tip of the bill. The measurement of the middle tail-feather is given in addition to the tail measurement as the former is less difficult to determine and is perhaps a more satisfactory measurement. The third toe, which is usually much curved, was measured with the aid of a flexible steel tape and includes the distance from the first scale at the base of the tarsus to the tip of the toe-nail.

In addition to measurements of the Heath Hen the average, maximum and minimum measurements of male and female Prairie Hen and male Attwater's Prairie Hen are given for comparison. I was able to measure but one female Attwater's Prairie Hen.

Measurements of Skins in the Museum of Comparative Zoölogy.

HEATH HEN, *Tympanuchus cupido cupido.*

Ten Males.

	Length	Bill	Tail	Middle tail-f.	Wing	Pinna	Tarsus	Third toe	Third toe-nail
Average	424.2	25.2	121.7	104.7	222.2	69.3	44.1	53.7	13
Maximum	455	26	128	109	225	72	50	57	16
Minimum	364	24	115	101	215	66	41	50	10

Ten Females.

Average	387.3	22.7	107.5	98.3	209.2	29.9	45.1	52.4	13.2
Maximum	442	24	115	106	219	32	49	57	15
Minimum	359	21	100	95	201	27	41	48	12

PRAIRIE CHICKEN, *Tympanuchus cupido americanus.*

Ten Males.

	Length	Bill	Tail	Middle tail-f.	Wing	Pinna	Tarsus	Third toe	Third toe-nail
Average	420.4	25.4	111.4	101.7	236.6	72.5	45.9	62.7	12.6
Maximum	456	27	122	104	245	82	49	67	14
Minimum	371	23	106	99	232	61	44	58	11

Ten Females.

Average	386.7	23.0	101.3	91.6	224.6	37.1	42.0	59.1	12
Maximum	439	25	107	98	232	41	44	62	14
Minimum	340	22	94	89	213	32	39	54	10

ATTWATER'S PRAIRIE CHICKEN, *Tympanuchus cupido attwateri.*

Ten Males.

	Length	Bill	Tail	Middle tail-f.	Wing	Pinna	Tarsus	Third toe	Third toe-nail
Average	381.9	24.9	102.2	88.8	229.5	62.5	45.2	62.0	10.7
Maximum	433	27	113	97	237	67	49	65	13
Minimum	361	23	96	85	224	56	42	59	9

One Female.

	339	25	89	82	221	25	45	59	11

The Natal Down of *Tympanuchus cupido cupido.*

The following description of the natal plumage is based on specimen number 16,341 in the collection of the Boston Society of Natural History. The bird was received from the Division of Fisheries and Game of Massachusetts. The age is not known but when compared with young Prairie Chickens of known ages, appears to be about four days old. The color determinations were made with the aid of Ridgway's standard nomenclature of colors (1912).

Under parts cream buff, the throat and middle of the belly approaching colonial buff. Sides of head marguerite yellow with three small black spots back of the eye. Upper parts tawny olive or Isabella color, the region of the rump snuff brown and russet, variously marked with black, the markings most prominent on the nape and the middle of the back. There is a conspicuous black mark on the forehead. The remiges and coverts marked with various tones of brownish drab and black, the feathers tipped with dingy white. The measurements of this specimen in millimeters are as follows: bill, 8.0; gape, 10.5; front edge of nostril to tip of bill, 5.0; tarsus plus third toe, 39.8; wing, 42.5; fifth primary, 23; length, 85.0; toes, first toe, 7.2; nail, 3.5; second toe, 18.0; nail, 4.1; third toe, 23.0; nail, 4.2; fourth toe, 18.5; nail, 3.6.

The natal down of the Prairie Chicken, specimen number 57,602 M. C. Z., two days old, hatched in captivity by Dr. John C. Phillips, is similar to the specimen described above but with the following differences. The under parts brighter yellow, the throat and sides of head amber yellow. This color seems to fade rapidly with exposure to light and air for in Prairie Hen chicks two weeks old the under parts are of a uniform cream-buff color. The upper parts of the two-day-old Prairie Hen chick are tinged with tawny, otherwise similar to the Heath Hen chick. The measurements are as follows: bill, 7.5 mm.; gape, 9.6; nostril to tip of bill, 4.5; tarsus plus third toe, 37; wing, 28; primary, 17; unsheathed tip, 8; length (skin), 79; toes, first toe, 6.5; nail, 3.5; second toe, 14; nail, 3.2; third toe, 19; nail, 3.0; fourth toe, 14; nail, 3.1.

Juvenal Plumage of *Tympanuchus cupido americanus.*

I have been unable to secure specimens of the Heath Hen in the juvenal plumage but it is reasonable to infer that the sequence of moults and plumages is similar to those of the Prairie Chicken given here.

The juvenal plumage is acquired by a complete postnatal moult. Certain feathers such as the remiges and their coverts appear very early, being represented the first day after hatching. These feathers grow very rapidly and by the end of the tenth day the birds are able to make short flights. At this time the scapulars have made their appearance and the tips of the feathers of the ventral tracts are unsheathed. The measurements

of a bird of this age, specimen number 55,518 M. C. Z., collected June 3, 1878, at Noble, Illinois, are as follows: bill, 10.5 mm.; tarsus plus third toe, 47; third toe, 22; wing, 68. The fifth primary has attained a length of 52 millimeters and the unsheathed portion is 45 millimeters.

The postnatal moult is overlapped by the postjuvenal moult in specimen 89,606 M. C. Z., collected July 9, 1895. In this bird three plumages are represented. The natal down is still present on the throat, sides of the head, ventral side of wings and can be seen among the feathers of the belly. The first primary is only about a centimeter in length and the second is only slightly longer. Primaries three to eight are fully grown; the ninth is new and is only 15 millimeters in length, the tip just beginning to expand; the tenth is 47 millimeters in length and also new. The ninth and tenth primaries represent feathers of the first-winter plumage. The crown of this bird is black and russet, the latter predominating. In the auricular region there is a patch of russet feathers that stand out prominently in the light-colored down of the sides of the head. Under parts white and shades of buff irregularly barred with dusky drab. Upper parts irregularly marked with black, and shades of buff and brown, many of the feathers with tips and shaft-streaks of white. Tarsi naked; the down has been lost and has not yet been replaced by feathers of the juvenal plumage. Papillae of the latter present. The juvenal plumage has much less of a russet or rufous color than is present in first-winter plumage. The measurements of the above specimen are as follows: bill, 17 mm.; wing, 132, fifth primary, 88; tarsus plus third toe, 66; third toe, 35; tail, 51.

A male, specimen number 248,823 M. C. Z., collected July, 1896, at Delavan, Wisconsin, is much older than the bird described above. In this bird the down of the head is completely replaced by the feathers of the juvenal plumage. The new feathers of the throat and sides of the head are nearly pure white. The first and second primaries are 62 and 83 millimeters in length respectively and only partly unsheathed. The third to the sixth are fully grown feathers of the juvenal plumage. The seventh is just a mere papilla; eighth and ninth partially developed and the tenth is completely grown. The seventh to the tenth primaries inclusive and a few new feathers along the side of the breast and scapular region represent the first-winter plumage. The measurements of this bird are as follows: bill, 19 mm.; wing, 170; tarsus-toe, 89; third toe, 43; tail, 82. Otherwise similar to specimen 89,606 described above.

First-Winter Plumage.

Tympanuchus cupido cupido and *T. c. americanus.*

The first-winter plumage is acquired by a complete postjuvenal moult excepting the two distal primaries. The first-winter plumage is similar to the adult winter plumage

but the younger birds are readily distinguished from the adults by their smaller size, by the more rufescent color of the upper parts and by the coloration of the throat which is cinnamon buff in contrast to the warm buff or cream color of the adults and the white throat of the juvenal. A Heath Hen, specimen 110,747 M. C. Z. taken on Martha's Vineyard, October 8, 1889, and a Prairie Hen, specimen 248,825 M. C. Z. taken September 23, 1900, at Darien, Wisconsin, represent the first-winter plumage. These two birds are very similar in coloration and without the labels would be difficult to identify. They are smaller and differently colored as compared with the adults taken at the same season of year, as indicated above. The feathers of the tail- and throat-region of the Prairie Chicken are new and not completely unsheathed. The fourth primary still retains some of its sheath and the third primary is only partially grown. These feathers are all completely grown in the Heath Hen. No pinnae are present in either of these representatives of the first-winter plumage.

First Nuptial Plumage.

The first nuptial plumage is acquired by a partial prenuptial moult which does not involve the wings and tail and body plumage but is restricted to the head region. The nuptial plumage which is completed by April has been previously described. Male birds kept in captivity at Martha's Vineyard began moulting by the first week of July but unfortunately none of the birds lived through the beginning stages of the process. The second or adult winter plumage is acquired by a complete postnuptial moult during the months of August and September. Specimens collected in October and November have the adult winter plumage complete.

From the adult winter plumage onward the plumages are repetitions of the nuptial and winter phases.

Pterylosis.

The general pterylosis of *Tympanuchus cupido cupido* is clearly shown in the accompanying photographs (Pl. 48) taken of a plucked Heath Hen which died in captivity June 23, 1923. The dorsal apterium is a long narrow lanceolate area and is considerably smaller than that found in other Grouse. The scapular portion of the dorsal tract has a well-marked fork and the feathers of the posterior portion of this tract present the characteristic arrangement shown in Plate 48, fig. 30. The cervical tracts are narrow and bear on each side the elongated feathers of the pinnae (Pl. 48, fig. 29). Beneath the pinnae are large naked spaces or apteria which form the conspicuous orange-colored coverings of the vocal sacs. The apteria above the eyes are prominent and highly colored in life. The union of the ventral tracts at the extremity of the sternum and other characteristic features of the ventral tracts are illustrated in figure 29 (Pl. 48). There are

eighteen rectrices which seems to be constant at least in all of the birds examined. In the specimen figured there are ten primaries but only sixteen secondaries. According to Nitzsch (Sclater, 1867, p. 113) there are twenty-eight remiges in *Tympanuchus cupido* but there is a variation in the number of secondaries in different Grouse as well as in different individuals of the same species. On the right wing of the specimen figured the ninth and tenth primaries are new; the ninth is only 15 millimeters in length and is unsheathed for a distance of only 4 millimeters; the tenth primary is 72 millimeters in length and unsheathed for a distance of 36 millimeters. On the left wing the ninth is represented by a mere papilla while the tenth has grown to a length of 49 millimeters. In the tail the three outer feathers on the right side are new and measure 68, 81 and 83 millimeters, respectively; only one rectrix on the left side is new measuring 61 millimeters with an unsheathed portion 40 millimeters in length. A few feathers of the middle upper tail-coverts and of the scapular region are new but the remainder of the plumage is old. The tarsi are feathered to the base of the toes.

Clark (1899, p. 649) states that the pterylosis of *Tympanuchus* is almost precisely like that of *Dendragapus* and according to Nitzsch (Sclater, 1867, p. 113, pl. 7, figs. 9 and 10) the characters of *Tetrao* are nearly like those of *Melcagris*.

Anatomy of the Vocal Sac.

The anatomy of the vocal sac and its relation to the respiratory system have never been clearly understood. The part this sac plays in modifying the sounds produced by the syrinx has been discussed in a previous section of this paper but I wish to emphasize here some of the more interesting anatomical features of these peculiar organs.

Dr. Elliott Coues (1896, p. 200) in his description of the pneumatocysts of birds states that "an *inter-clavicular* air space, quite constant: this, with its cervical prolongations, furnishes the great 'air drums' of our pinnated grouse and Cock-of-the-plains." Dr. Coues' statement, presumably, was based upon theoretical assumptions rather than upon experimental evidence and dissection. I have been unable to find any published statement based on a study of living captive birds and dissections of freshly killed specimens. Mr. James P. Chapin of the American Museum of Natural History made a painstaking and detailed study of a Prairie Chicken preserved in formaldehyde, but the results of his injections were unsatisfactory because of a broken windpipe. Mr. Chapin's paper was read at the American Ornithologists' meeting held in Chicago in 1922, but he has not as yet published his manuscript.

At Martha's Vineyard I had a good opportunity to study the birds at close range when they performed on top of my blind and I also had captive birds for observation and freshly killed specimens for dissection.

Experiment with the living bird.—When a rubber tube is inserted into the mouth of the living bird the vocal sac is easily inflated by blowing into the free end of the tube (Pl. 49, fig. 31). It is also possible by this procedure to inflate the entire respiratory system, including the air spaces, through the glottis. The same result can be obtained by blowing directly into the mouth. One could not prove by this experiment alone the exact nature of the vocal sac and its relations to the respiratory system but further tests and dissections are necessary. An examination of the inflated sac, however, reveals that the inflated region which to the field observer appears as two lateral sacs is merely one large sac divided on the antero-ventral aspect by feathers.

Experiment with the freshly killed bird.—When a canula attached to a rubber tube was inserted into the glottis it was easy to inflate the lungs and the whole air-space system including the interclavicular air spaces, but it was impossible, by repeated attempts on several different birds, to inflate the vocal sacs if care was taken not to allow air to issue out of the glottis to the pharynx. I then injected colored gelatine through the glottis into the trachea and was able to fill the whole respiratory system but none of the injected mass reached the region of the vocal sac. A subcutaneous injection made in the region of the vocal sac fills a large space but this procedure merely forces the material between the loosely arranged fibers of the subcutaneous tissue. One may also force air under the skin in a similar way, but I was unable by these methods to establish any connection with the respiratory system.

In still another specimen the orange-colored integument covering the vocal sac was cut exposing the trachea, oesophagus and muscles of the neck (Pl. 49, figs. 31, 32). A rubber tube was inserted in the mouth and a slight pressure exerted by blowing into the tube resulted in the instant inflation of the respiratory system and oesophagus which protruded through the slit in the integument (Pl. 49, fig. 31). The dissection then immersed in water showed no escape of air. The tube was then left intact and the bird skinned so that the oesophagus and trachea were completely exposed. By again blowing into the tube the anterior end of the oesophagus became distended and also the crop as shown by figure 33 (Pl. 49). The region of the oesophagus between the crop and the air sac could never be distended with all the pressure I could exert by blowing, but the anterior end easily enlarged to the size of a large orange.

These experiments prove conclusively that there are not two sacs, as generally supposed, but a single one which is a specialized modification of the anterior end of the oesophagus. The sac is not subcutaneous and is not connected with any part of the respiratory system except through the pharynx.

How is the oesophagus inflated and how is the "booming" sound produced? When the birds performed on the roof of my blind I was able to observe them through cracks

between the boards or by a system of mirrors if the birds were not in a position to be seen directly. This offered unexcelled opportunities to observe details (see p. 544).

The sounds are produced when the sac is being inflated and never when the sac is deflating. During inflation the bill is tightly closed and the anterior end of the tongue is pulled back slightly and pressed against the roof of the mouth through the contraction of the mylo-hyoid muscles. It is evident that the sac is inflated by air coming from the respiratory system *via* the pharynx. The air is prevented from being exhaled by the tightly closed mandibles and by the tongue pressed up against the internal nares (Pl. 49, fig. 32) in the roof of the mouth. When the tongue is thus drawn back and elevated the glottis is placed in a position directly in front of the oesophagus. The hyoid bones extending laterally from the base of the tongue are embedded in connective tissue surrounding the oesophagus and thus serve to distend the anterior end of the oesophagus when the tongue is in its proper position for inflating the sac. The deflation takes place suddenly and at times I was able to hear the air issue from the nostrils or mandibles of the bird while on other occasions there was no evident expulsion of air. The sound of escaping air in the latter case may have failed to register on my ears or the air may have been taken into the lungs and air sacs by way of the glottis. Such a sudden deflation could not be made through small connections with the trachea or air spaces. The expulsion of air is accomplished by the contraction of integumentary muscles and by the elasticity of the tissues of the oesophagus. I was unable to find any evidence to indicate that subcutaneous pneumatic spaces share in the process of inflation to form the vocal sac.

There is nothing about the sac which can produce vibrations and it is obvious that the tooting sounds are produced by the syrinx, the usual vocal mechanism of birds. The sound waves issue along with the air forced from the respiratory system. The air sac with its large volume of enclosed air serves as a resonator which modifies the character of the sounds and which gives to them their great carrying power.

Pinnae muscles.—The long stiff feathers of the pinnae can be moved about at will by the bird although their extreme forward position at the time of booming may be due in part to the inflation of the large air sac. The movement of these feathers under ordinary conditions is accomplished by three pairs of muscles which extend from the cervical vertebrae to the integument of the neck in which the quills of the long pinna feathers are embedded (Pl. 48, fig. 29). These muscles are not always coördinated but the pinna of one side may be forward while the one on the opposite side is pointed in a backward direction. When the bird is at rest or when it is going through the booming performance the pinnae are usually symmetrically placed.

Visceral Organs.

It is not practicable in a paper of this nature to give a detailed account of the anatomy of the visceral organs but it seems desirable to give measurements of parts of the alimentary tract. The measurements of the alimentary tract of specimen number 4 are given in the following table. Care was taken to measure the parts under practically the same tension.

Table of measurements of the alimentary tract.

	mm.
Tip of bill to cloacal opening	1012
" " " " attachment of caeca	906
" " " " anterior end of gizzard	232
" " " " " " " proventriculus	211
" " " " crop	150
Intestine from gizzard to caecal junction	645
" " caeca to the cloacal opening	106
Length of proventriculus	21
" " gizzard	45
" " right caecum	195
" " left "	242
Tip of bill to bronchial tubes	192
Length of bird (tip of bill to tip of tail-feathers)	459

Comparative measurements of the intestine and caeca.

	No. 1. mm.	No. 2. mm.	No. 6. mm.	No. 7. mm.
Gizzard to cloacal opening	926	751	822	1025
" " caecal junction	805	645	735	922
Right caecum	368	195	435	345
Left caecum	355	242	461	352

It is at once apparent that there is great variation and but little correlation in the relative length of the parts of the alimentary tracts of different individuals of the Heath Hen.

Since it is of importance to know the size of the reproductive organs to serve as an index to the sexual condition and vigor of the birds the following measurements of the testes are given.

Measurements of testes.

Date when bird was killed or died in captivity.	No. 1. April 24, 1923	No. 2. May 26, 1923.	No. 4. June 23, 1923.	No. 6. April 15, 1924.	No. 7. May 20, 1924.
Left testis, width	8.1	7.0	6.1	8.2	10.5
" " length	13.5	10.5	8.2	12.9	11.9
Right testis, width	7.8	6.5	5.0	9.3	10.5
" " length	12.1	11.2	8.1	12.1	12.1

Notes on the Skeleton.

By Glover M. Allen.

The skeleton of the Pinnated Grouse has been described in some detail in two papers by Shufeldt (1882, 1909), who based his study upon western birds. He pointed out the unusual characters presented by this genus and indicated its relationship to the Sharp-tailed Grouse (*Pediœcetes*). It will therefore suffice here to review briefly the general features of the skeleton and to compare that of the western with that of the eastern form.

The skull presents the general characters found in Galline birds. It has a squarish brain case as viewed from above; arched supraorbital borders enclosing a shallow depressed area; the nasals distinct basally on a flattened area in front of the orbit, but very narrow over the nostrils. The narial opening is large and oval, with the greater end posteriorly. In side view the large ethmoid plate forms a nearly complete vertical partition between the orbits, with a very narrow slit dorsally where it fails to unite completely with the frontals. The latter overarch it above shutting it out from the upper surface of the skull. The palatal bones are slender and widely separated (schizognathous) enclosing a slit from 3 mm. wide in front to 6 mm. posteriorly. Their proximal ends are expanded and pressed against each side of the slender vomer for nearly its whole length. Their posterior ends reach slightly (2 mm.) behind the level of the vomer and articulate by a small facet with the distal ends of the pterygoids. The latter articulate by an oval facet with sessile facets on either side of the basipterygoids. A striking feature is the very long slender process projecting forward from the anterior corner of the squamosal. The ear opening is large, about 5 mm. in transverse width, situated at the postero-ventral corner of the skull.

A prominent character of the lower jaw is the long oval window (10 mm.) just back of the middle, and the slender and sharply upturned rod of bone forming the posterior border.

The vertebral column consists of fifteen cervicals, followed by four fused dorsals, then one free dorsal anterior to the sacrum. This latter includes sixteen fused vertebrae (one more than in *Gallus*) followed by *six* free caudals and a thin, pointed pygostyle. Shufeldt has shown that in having six free caudals, *Tympanuchus* and *Pediœcetes* differ from other American Grouse in which there are normally but five.

The third and fourth cervical vertebrae in dorsal aspect differ from the others in being of almost equal width from front to back, whereas the others are very much narrowed in their middle portion.

A conspicuous feature of the four fused dorsal vertebrae as well as of the single free vertebra following them, is their deep keel whose ventral edge is so elongated antero-posteriorly that in both the Dakota specimens before me the first and second are broadly

fused to include a round foramen, while those of the three following are joined by a slender isthmus, leaving the second and third only unmited below. The ventral keel of the first of the four fused dorsals is even expanded laterally, forming an oval plate for muscle attachment.

The pelvis exhibits several remarkable features. In the breadth and relative shortness of the anterior portion of the ilia it agrees with the Grouse rather than with the Pheasants, but shows almost an extreme development of the posterior wings of the ilia, which are not only very thin (as compared with *Gallus*) and relatively shallow in side view, but are enormously expanded laterally so as to extend well beyond the socket for the hind leg and overhang the slender pubis by a lip-like cornice developed as an extension of the prominent lateral ridge. As pointed out by Shufeldt the only other Grouse showing this peculiarity is the Sharp-tail (*Pediœcetes*). The pubis is a thin slender rod, closely appressed against the ventral side of the ischium and extends about 16 mm. posterior to the edge of the broadly expanded ischium. There is also a small oval foramen (5 mm. long) between the pubis and ischium anteriorly.

Noteworthy is the distinct separation of the inner margin of the ilium from the sacral vertebrae in its terminal fourth. The ribs are relatively broad with large and widely expanded uncinate processes on ribs 2–6, whose separate line of fusion each to its appropriate rib is still obvious in the specimens at hand. The ribs are seven on each side, of which the first pair is short and free, borne on the last free vertebra. The second pair is broader, more curved in both lateral and frontal aspects, but again is free distally. The third to sixth pairs articulate with the sternum by the intervening costal ribs, while the seventh pair is united by its costal ribs to the hind margin of the costal ribs of the sixth pair. In these respects the arrangement is typical of the group.

The sternum, as usual in the Galline birds, has a long bifurcate xiphioid process on each side separated by a deep cleft from the median portion of the sternum with its keel. This process in *Tympanuchus* has the inner arm extremely slender and long, ending in an expansion that curves forward in front and inward at its posterior tip. The anterior or outer arm of this process is slightly wider but only about one half as long as the inner, and ends in a similarly expanded tip. The manubrium of the sternum, as in other Grouse, is perforate in the line of the grooves for the reception of the coracoids.

The most obvious peculiarity of the scapula is the marked expansion of its distal end, a trait apparently not found among the other genera of the group. The furculum has its distal expansion proportionately large (equal to one third the total length of the bone) but the arms are rather slender. Both coracoid and scapula are pneumatic.

The wing bones are short but do not depart very greatly in structure from those of *Gallus*. The humerus alone is pneumatic, and has the usual stout head with full, rounded

tuberosities. Its greatest length is practically equal to that of the ulna together with its distal carpal, some 71 mm. The metacarpals of digits II and III are fused at their tips, enclosing a long narrow space between them, which is proximally crossed by a blunt bony projection from the postero-internal edge of digit II, forming a small foramen. The basal phalanx of this digit is widely expanded and the terminal phalanx of digit III is closely appressed against its posterior border. The total length of the hand (excluding the carpal bones) exactly equals that of the ulna, about 66 mm.

In the leg the femur alone appears to be pneumatic. Compared with *Gallus*, its bones are less massive but otherwise essentially similar. The femur is strongly and rather evenly convex forward, about three fourths the length of tibiotarsus. The patella is distinctly ossified. The tibiotarsus shows the usual pronounced cnemial crests, which, however, reach only about 3 mm. above the general level of the top of the tibia. Below its articulation with the tibia, the fibula becomes very slender and ends free some 35 mm. from the distal end of the tibiotarsus.

The tarsus (about 49 mm.) is just half the length of this latter bone, and just equals the combined length of the bones of the longest toe. It is therefore relatively rather short. Along its posterior margin, as in other related genera, a thin plate of bone is present, from the proximal edge of the summit of the tarsus to the base of digit I. This plate is separated from the main shaft at its upper two-fifths, bridging over a perforation about 10 mm. long.

Of the eastern representative of the Pinnated Grouse, I have had for examination one complete and four imperfect skeletons from Martha's Vineyard. A detailed comparison of these with the two from North Dakota shows a very close similarity as might have been expected in the case of birds so nearly related. The few points of difference are given below, but even these may have less significance than appears from the small amount of material examined.

In general, the greatest width across the broad sacrum is slightly less in the eastern bird. The pygidium is constantly and decidedly less in its dimensions and the uncinate processes of the ribs are less broad and more ligulate. There is probably some variation in the number of free caudal vertebrae between the synsacrum and the pygidium, for although Shufeldt states that it is six in the western bird (and that number is present in the two North Dakota specimens I have examined) thereby marking an important difference from other American Grouse except *Pediœcetes*, yet in one of the three Martha's Vineyard birds in which all the vertebrae are present, the number is six and in the others only five, but in the first it seems clear that the anteriormost of the six terminal vertebrae would shortly have fused to the rest of the synsacrum. Apparently then there is a reduction in the size of the pygostyle and in the number of free caudal vertebrae in

the eastern bird, or perhaps, these parts have developed greater size and mobility in the western form.

A second apparently constant difference is in the shape of the head of the furcula or "wishbone." In the eastern bird, this is distinctly diamond-shaped in side view, with the dorsal edge forming a wide obtuse angle nearly like that of the ventral edge, whereas in the western bird the head instead of being pointed posteriorly is broadly rounded, much as in *Gallus*.

For the rest, the eastern form seems to be very slightly smaller, with the scapula, furcula, wing, tibia and tarsus all a few millimeters shorter. These differences are small, and perhaps due in part to age or to individual variation. For comparison, the lengths of the principal bones of six specimens studied are given in the following table:

Skeletal Measurements of Tympanuchus.

	Male 445 Martha's Vineyard	Male No. 1 Martha's Vineyard	No. 7 Martha's Vineyard	No. 9 Martha's Vineyard	Male 289575 U. S. N. M. No. Dakota, Grafton	Male 289576 U. S. N. M. No. Dakota, Grafton
Skull, greatest length	63	....	....	....	63.5	63
" greatest width	29.5	....	....	....	29	....
Neck vertebrae, combined length	143	135	131	137	146	149
Fused dorsal vertebrae, length	39.5	38	38.5	38.5	38.5	39.5
Sacrum, width anteriorly	47	42	43	42.5	47.5	47
" " posteriorly	68	64	64.5	65.5	72.5	72
Pygidium, greatest length	15.4	....	....	15	19.5	18.5
Scapula, greatest length	70	68	68	67.5	74	75
Furcula, " "	54.3	54	55	57	59	61
Coracoid, " "	50	51	49.5	50.5	54	53
Sternum, " "	110	105	110	109	112	118
Keel, " "	97	88	92	92	95	101.5
Lateral process, last sternal rib to tip	68	63	62	67	67	69
Humerus, greatest length	69	....	....	....	72	71
Ulna, " "	64	....	....	....	68	67
Basal phalanx of digit II	35	....	....	....	42.4	37.5
Femur, greatest length	70	68.5	66	68	72	70
Tibiotarsus, " "	93	....	....	....	98	97
Tarsometatarsus, "	47	....	....	....	53.5	51

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EXPLANATION OF PLATES.

(All figures are from original photographs by the author unless otherwise indicated.)

PLATE 40.

General views of the Heath Hen reservation.

Fig. 1. The Heath Hen reservation looking eastward from a former favorite drumming field. The duck pond is at the left and the superintendent's house and barn appear in the background. May 14, 1923.

Fig. 2. Scrub oaks and huckleberry bushes typical of the area inhabited by the Heath Hen. June 24, 1923.

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Gross on the Heath Hen.

Heliotype Co. Boston

PLATE 41.

Scenes on the "drumming" fields.

Fig. 3. Two male Heath Hen drumming in an open field on the farm of James Green at West Tisbury. March 28, 1927.

Fig. 4. Two male Heath Hen feeding among the dead grass of an open field. March 29, 1927.

Fig. 5. Two male birds on the top of the observation blind located in the center of the main "drumming" field of the reservation. An adjustable mirror is mounted at one corner to facilitate the study of the birds by an observer stationed inside of the blind. The Canada Goose in the foreground is one of a large flock which was allowed to forage on the field. April 19, 1923.

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GROSS ON THE HEATH HEN.

HELIOTYPE CO. BOSTON.

PLATE 42.

Characteristic poses of the Heath Hen.

Fig. 6. Male bird photographed near the end of the morning feeding period. Crop greatly distended with food. Reservation, April 6, 1924.

Fig. 7. Side view of a male bird in the initial stage of "tooting" or "drumming." West Tisbury, April 2, 1926.

Fig. 8. Rear view of a "tooting" male displaying the white under tail-coverts and relative position of the cervical tufts or pinnae. West Tisbury, April 1, 1926.

Fig. 9. Antero-lateral aspect of a "tooting" male. Reservation, April 14, 1923.

Fig. 10. A group of five males feeding among the dead grass on the farm of James Green, West Tisbury, April, 1926.

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GROSS ON THE HEATH HEN.

HELIOTYPE CO., BOSTON

PLATE 43.

Close photographic studies of the Heath Hen.

Fig. 11. Male bird strutting. West Tisbury, March 28, 1927.
Fig. 12. A male bird at the climax of the "tooting" performance. West Tisbury, March 29, 1927
Fig. 13. A male in the initial stage of the "tooting" performance. Reservation, April 12, 1923.
Fig. 14. A male in walking posture. West Tisbury, March 29, 1927.
Figs. 15 and 16. Postures assumed by the birds when startled or suspicious of danger. West Tisbury, March 29, 1927.

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GROSS ON THE HEATH HEN.

HELIOTYPE CO. BOSTON.

PLATE 44.

Courtship of the Heath Hen.

Fig. 17. A male Heath Hen going through his courtship in the presence of the indifferent female. Photograph by Dr. George W. Field. Loaned through the courtesy of the Division of Fisheries and Game of Massachusetts.

Fig. 18. An enlarged and retouched photograph of a "tooting" male Heath Hen. An important part of the courtship of the Heath Hen. Photograph by Dr. George W. Field. Loaned through courtesy of the Division of Fisheries and Game of Massachusetts.

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Gross on the Heath Hen.

Heliotype Co. Boston.

PLATE 45.

Nest and eggs of the Heath Hen and of the Prairie Hen.

Fig. 19. Nest and nine eggs of the Heath Hen located in a typical low growth of scrub oak. This nest was photographed by Dr. Field on June 2, 1906, the first nest of the Heath Hen to be photographed and studied. On June 4 the eggs were placed under a bantam hen. One egg was hatched on June 20 but the chick was killed by the hen; the other eggs failed to hatch. This set of eggs and the chick are now a part of a display group in the American Museum of Natural History, New York (see Bird-Lore, vol. 9, p. 254, 1907).

Fig. 20. Nest and nine eggs of the Prairie Hen, *Tympanuchus cupido americanus*, found by the author in a timothy field, three miles east of Clinton, Illinois, on May 16, 1907. This nest is typical of the nests found on the plains of the Middle West. The surroundings of low grass are strikingly different from the scrub-oak environment of the nest of the Heath Hen.

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GROSS ON THE HEATH HEN.

HELIOTYPE CO. BOSTON

PLATE 46.

Stages in the development of the Prairie Hen and a nesting female Heath Hen.

Figs. 21, 22, 24, 25. Prairie Hen chicks from the natal down to the completed juvenal plumage. Photographs, by Dr. John C. Phillips, of chicks reared in captivity at Wenham, Massachusetts.

Fig. 23. Female Heath Hen incubating her eight eggs in a nest located among the sweet fern and scrub oaks. The nest was found June 5, 1912, and the photograph taken by Dr. George W. Field on June 28, 1912 (see Bird-Lore, vol. 15, p. 355, 1913). Photograph loaned by courtesy of the Division of Fisheries and Game of Massachusetts.

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GROSS ON THE HEATH HEN.

PLATE 47.

Food of the Heath Hen.

Fig. 26. Bayberries, *Myrica carolinensis*, used as food by the Heath Hen. April 3, 1924.

Fig. 27. Acorns of the black scrub oak, *Quercus ilicifolia*, one of the dependable foods used by the Heath Hen chiefly during the winter months. April 3, 1924.

Fig. 28. Crop contents of a male Heath Hen trapped on the reservation April 5, 1924. There were 1846 leaves of sheep sorrel (*Rumex acetosella*) and parts weighing 32.2 grams in the crop of this one bird. The only other food was thirty-eight grains of corn (shown in the picture at the left) secured from the bait used in the trap.

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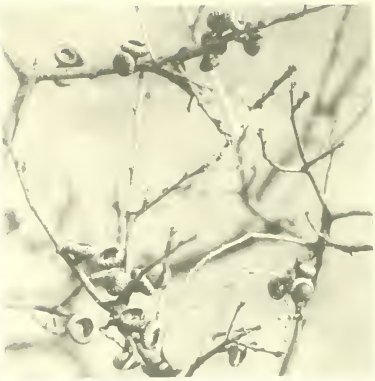

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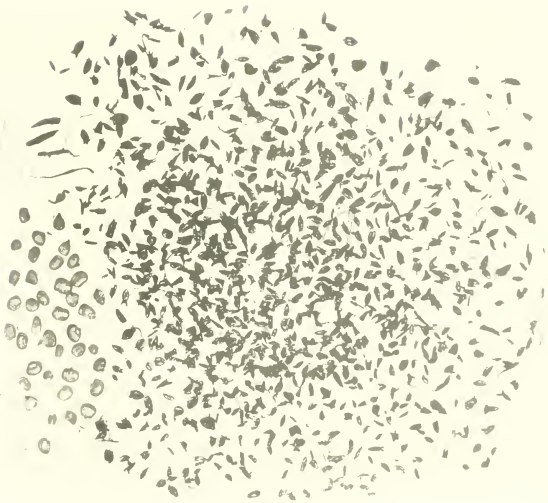

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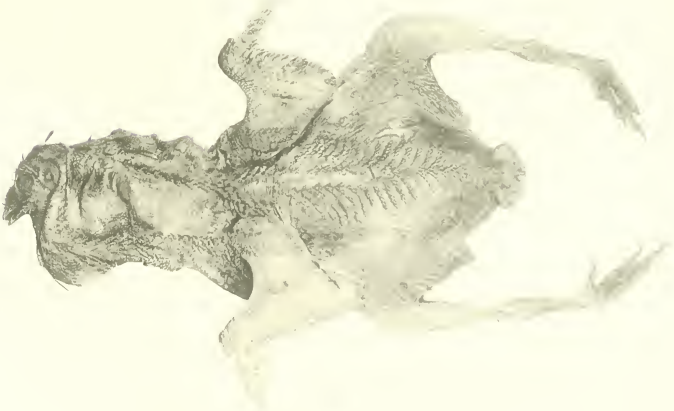
Gross on the Heath Hen.

PLATE 48.

Pterylosis of the Heath Hen.
Specimen died in captivity, June 23, 1923.

Fig. 29. Ventral aspect of the partially plucked bird showing the pinnae, rectrices, remiges and the arrangement of the ventral feather-tracts (see text for description).

Fig. 30. Dorsal view of the bird completely plucked. Skin slit on ventral side and spread out to show arrangement of feather tracts.



GROSS ON THE HEATH HEN

HELIOTYPE CO., BOSTON

PLATE 49.

Anatomy of the vocal sacs.

Fig 31. Orange integument covering sides of vocal sac slit open. The sac, a modified enlargement of the anterior end of the oesophagus (shown partly protruded through the cut), has been distended by blowing into the rubber tube inserted into the mouth. It was easy to inflate the entire air-sac system connected with the respiratory organs but no air issued from the cut indicating that the vocal sacs are not subcutaneous spaces. If the canula was inserted through the glottis into the trachea and care taken not to allow air to be forced back into the pharynx, the whole respiratory system was inflated without affecting the vocal sacs, which indicates that the sacs are not inflated through the respiratory system (see text).

Fig. 32. Pharygeal region showing internal nares, openings which are closed off by the elevation of the tongue during the period of the inflation of the air sac. The opening of the glottis is shown at the base of the tongue. The air sac just posterior to the glottis is slightly distended with cotton.

Fig. 33. Skin dissected away from the neck and side of the head. The air sac (modified anterior end of the oesophagus) is slightly inflated with air. The trachea or wind-pipe is on the ventral side of the air sac. The hyoid bones which extend in a postero-lateral direction from the base of the tongue are shown imbedded in the tissue comprising the walls of the air sac. These bones aid in distending the sac during the tooting performance. The glottis is then in a favorable position to inflate the air sac with air coming from the respiratory system through the trachea (see text).

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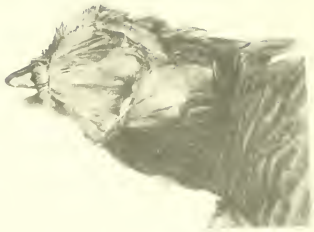

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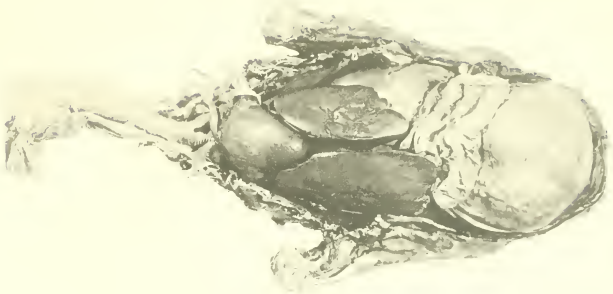
Gross on the Heath Hen.

PLATE 50.

Internal anatomy and disease.

Fig. 34. Male bird trapped May 21, 1923, and died in captivity on May 26 after only five days of confinement. Death due to the disease, "blackhead." The congested area is shown as a large spherical mass located in the abdominal region (see text). This figure also shows the trachea, syrinx, heart and liver in normal position and condition.

Fig. 35. Same specimen as shown in Figure 34 but with the intestinal tract containing the diseased mass thrown to one side. This view shows the kidneys, testes, stomach and proventriculus in a normal condition.



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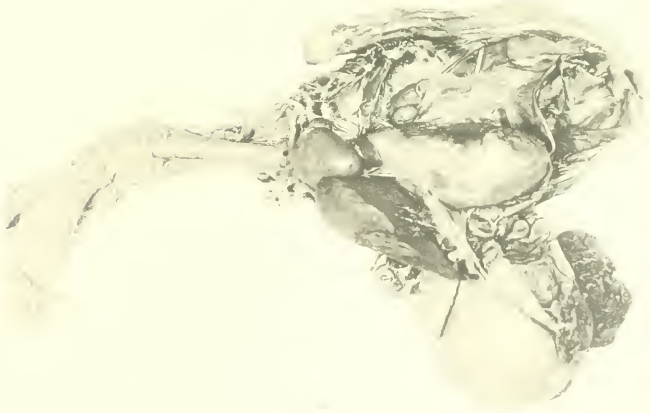

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